1952

Annual Report

Northeastern Forest Experiment Station

Upper Darby, Pennsylvania
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NORTHEASTERN FOREST EXPERIMENT STATION

INTRODUCTION

THE SPOTLIGHT ON NATURAL RESOURCES

THE NEED OF CONSERVING our natural resources and replacing our renewable resources has been brought to public attention repeatedly during the last year. The most complete report was that of the President's Materials Policy Commission, known as the Paley Report. Though the recommendations of the Commission have not been accepted universally, the facts regarding the present situation are not subject to dispute.

"The United States has used up its resources considerably faster than the rest of the free world," the report states. "With less than 10 percent of the free world's population and 8 percent of its land area, the United States consumes close to half the free world volume of materials." We have completed the transition from a raw-materials-surplus nation to a raw-materials-deficit nation and from a net exporter to a net importer of many of our vital materials.

A second item of national interest was the announcement of a citizens' conference on the conservation and development of natural resources, to be held in March 1953, in Washington. The conference has been called by Resources For The Future, Inc., which was established by a committee of citizens to serve the Ford Foundation as an advisory group on resources.

The importance of research is emphasized in each of these events. The Paley Report, in its chapter on timber resources, recommended that forest-research programs of all agencies be further strengthened, and that the Federal forest-research expenditures by the Department of Agriculture be doubled. Resources For The Future, Inc., will assist the officers of the Ford Foundation in planning a program and working in the field of research and education for resources development and conservation.

A third item of interest in the field of forest research was the appointment by the Secretary of Agriculture of a National Forest Research Advisory Committee. At the first meeting of the Committee in Washington, December 1-3, 1952, intensified research in seven broad fields was recommended. These fields include forest fires, forest insects and diseases, watershed management, forest economics, forest utilization, forest management, and range management.

At the regional level, the Northeastern Forest Experiment Station has continued to benefit from the cooperation and advice of the Northeastern Forest Research Advisory Council. The research activities of the Station continued in accordance with carefully considered long-range plans, with little variation from the established program. Results of this research have been reported in Station publications and articles in technical journals. In the following pages progress during the past year is set forth.

SOME RESEARCH HIGHLIGHTS

In Forest Management

In forest-management research the major activity continues to be the establishment and operation of compartment studies to discover and compare the biologic and economic results from different combinations of measures and treatments. During the past year preliminary instructions for record-keeping were considered in the light of 3 years' experience, and are being revised to simplify field and office work and to provide greater flexibility in the conduct of the studies.

Other progress on the experimental forests was made in arranging for completion of the road systems on the Bartlett and Fernow Experimental forests. On the Bartlett the work is being done by contract; on the Fernow by force account and rented equipment. Another spur road was completed on the Massabesic Experimental Forest. Most urgent road needs now are on the Penobscot, Pocono, Paul Smith and Hopkins forests. Financing construction of roads on the first three of those forests presents problems because the forests are privately owned.

Cutting on the compartment studies lagged somewhat behind schedule. Cutting on the Hopkins and Paul Smith forests was affected by the glut of pulpwood from the timber thrown by the big wind of November 25, 1950. Normal irregularities in demand raised problems in disposing of pulpwood from the Bartlett; and at year's end the Penobscot had to accept a cut in the price of its wood.

The commercial operation of these compartments is bringing home to us the difficulties to be dealt with in translating the results of plot studies into the management of larger properties. This is one purpose of the pilot-plant studies. The next step, when we are ready for it, will be to test compartment results on a larger management unit that approaches a regular commercial operation in size.

While the compartment pilot-operation studies now get the bulk of effort and attention at the research centers, they are supplemented and strengthened by a variety of smaller projects and studies. During the year we collaborated with the Division of Engineering of Region 7 on the use of silvicides to supplant mowing for control of woody species along roads, rights-of-way, trails, and on ski slopes. A commercial product designed to increase the wettability of soil was tested to see if it had value in increasing germination and establishment of seedlings. In another study a commercial preparation that improves the soil structure was tested by application around planted seedlings.

In our continuing search for methods of preparing scrub oak land for planting we found that a machine with large raking teeth mounted on a 70-hp. tractor bulldozer blade was effective in ripping out the scrub oak, but at a cost somewhat higher than our goal. Work was practically completed on the establishment of some 900 plots for the study of growth of spruce and fir being made in cooperation with pulp and paper companies in Maine. A time study on the felling of hardwood timber indicates that a man is more than twice as efficient when working alone with a 1-man power saw as he is when serving as a member of a 2-man crew using the old hand-drawn crosscut saw.

Watershed Studies

Watershed-study activities on the Delaware-Lehigh Experimental Forest during 1952 consisted of collection of data and development of techniques to evaluate water relations for the Dilldown Watershed. Four hydrologic years have passed since records were begun of precipitation, streamflow, climatic, and related data for this area. Measurements and computations are now being made to determine the amount of water supplied to the watershed by precipitation and how it is disposed. A day-to-day accounting of water in the watershed is being made by evaluation of precipitation, interception losses, water held in snow cover, changes in moisture storage in the soil profile, evapo-transpiration losses including those from the riparian zone, changes in ground-water storage, and streamflow from the area.

At present it appears that another year will complete the calibration period for this watershed. When the calibration is completed, measures will be taken to convert the present scrub oak cover to commercially valuable timber stands as rapidly as possible. A detailed survey of the vegetation on the watershed was completed during the year. Information from this survey will indicate what portions of the watershed will require planting of tree species, what part is returning naturally to satisfactory stands of desirable species, and what areas are too rocky to plant or revegetate naturally within a reasonable time.

The study of snow accumulation and melt, and type and depth of soil freezing, was continued through the second winter. Analysis of data was started to determine the relative rates of snow accumulation and melt for different land-use and forest conditions. This will be followed by analyses to determine the type, depth, and extent of soil freezing as influenced by the different land uses and forest conditions.

A study of erosion from logging skid roads was started on the Fernow Experimental Forest. Relationships between erosion rates and steepness and length of grade are being determined. These relationships may be used as guides in establishing the desirable spacing of water bars or other devices to remove storm water from the road surfaces. These studies will be continued to test various erosion-control measures for use after logging, and similar studies will be conducted on logging haul roads.

Forest Survey

All phases of field inventory of the forest survey were completed in New York State. Work continued in Pennsylvania, mainly in the western part, where an additional 2,511,000 forest

acres were covered. This brings the forest area covered in this State to approximately 9,000,000 acres, representing about 60 percent of the field job.

Field work was initiated in Connecticut in June, and by the end of the year 1,316,000 forest acres had been covered. This acreage represents about 67 percent of the total field job for Connecticut.

State statistical reports were published for Vermont and West Virginia. Unit reports for New York Forest District No. 7 and the western section of Maryland were also published.

Forest Economics

Aside from the forest survey, the Division of Forest Economics has been engaged in a number of other projects. Together with representatives of the state agricultural experiment stations, it has participated in the research activities of the Northeast Regional Technical Committee on Marketing of Forest Products. In cooperation with Harvard Forest, further study has been made of the adaption to forestry of the budget-analysis technique applied so successfully in farm-economics research. This study is related closely to the compartment operations on the Station's experimental forests. And finally, at the request of Governor Sherman Adams, the New Hampshire Forest Policy Committee was assisted in preparing a report on the State's forest situation and in organizing the various policy suggestions put forth for consideration.

Numerous other economic problems of forestry in the Northeast require attention. Very little is known of the factors motivating owners of small forests. What part do economic factors play? What adjustments should be made in existing institutions--taxation, ownership arrangements, or credit facilities, for example--to bring about better forest practices on small holdings? These and many similar problems await further study.

Flood Control Surveys

The Division of Flood Control Surveys has been concentrating on the Resources Survey of New England and New York which is being made by an inter-agency committee established by the President in 1950. Working in close collaboration with other agencies of the Department of Agriculture and with the other Federal departments represented on the committee, a comprehensive program of land treatment is being devised and its effect on soil erosion and water-flow reduction determined. Since there is little precedent for much of this work, solution of the many problems that have arisen has been possible only because of the close working relationships that have developed

within the group of Federal agencies and between them and the State representatives.

Forest Utilization

The Forest Utilization Service continued to work with most of the northeastern organizations interested in utilization. Its relation to these organizations varies: in some cases personnel of the division function as chairmen of working committees; in others as committee members, members of boards of directors, program participants, or general advisers.

In addition to working with these local groups, members of the FUS serve on the Forest Service Log Grade Committee, the Forest Service Equipment Development Committee, and as chairman of the Working Committee of the Northeastern Technical Committee on the Utilization of Beech. The Station published three papers in a series of 23 now being prepared through this committee, and additional papers have been prepared for publication.

Another important activity was a Station-sponsored clinic on wood-preservation research held at New Haven, Connecticut, under the auspices of the Connecticut Agricultural Experiment Station. This meeting led to the formation of the Northeastern Wood Preservation Conference--a group that has as its objective the development of a program of coordinated research in this field.

Publications

The number of publications by members of the staff and cooperators during 1952 was 70, a marked increase over the 51 publications reported for 1951. This is a reflection of an effort made to reduce delays in the reviewing process, especially in regard to older manuscripts that had been delayed.

Besides the articles and papers published, 16 articles submitted to trade and professional journals during the year have been accepted but not yet published. And 18 additional manuscripts have been approved and edited and are awaiting printing in the Station printing plant.

An increase was also noted in the number of new manuscripts coming in from the research centers, as studies begun in past years have begun to produce results.

STATION OPERATIONS

In spite of decreased appropriations and increasing unit costs, the research program of the Station has been maintained or intensified in all lines except Flood Control Surveys. This

has been possible because of increased cooperation from private and non-Federal public agencies and through internal economies. The cooperation received takes many forms, including the provision of quarters for field men; the contributed use of land, improvements, and research installations; the use of aerial photos; personal services; and cash contributions. The estimated value of these contributions in 1952 was close to $140,000. Without their continuance the research program of the Station would suffer greatly.

Research Center Organization

Reorganization of two research centers was accomplished during the last year. The White Pine and Northern Hardwood centers were combined to form the new White Pine-Hardwood Research Center with headquarters at Laconia. Tom McConkey is in charge of work at the Massabesic Forest, and Bob Wilson has been assigned to work in white pine outside the forest. The Beltsville Experimental Forest was separated from the Coastal Oak-Pine Center and now is headquarters for the newly created Virginia Pine-Hardwood Center.

Personnel Changes

There was an unusual number of personnel changes during 1952, many of them stimulated by the reduced appropriation for Flood Control Surveys. Arthur Bevan and Kenneth Clark retired at the end of August, and Marinus Westveld retired on December 20. Westveld is continuing his relations with the Station as a collaborator.

Six men--Williamson, Doverspike, Rogers, Kidd, Caporaso, and Mendel--transferred to Washington to work with a new photo-interpretation project in cooperation with the Air Force. Gedney transferred to the Pacific Northwest Forest Experiment Station; Barrett to the George Washington Forest in Region 7; and Cavallero to the Corps of Engineers.

Two men, Hutnik and Church, returned from educational leave; and Huttinger returned from military leave. Schreiner returned from a year in Europe where he studied poplar culture under a Fulbright fellowship. Potter and McLintock left for the Universities of Maryland and Yale respectively for advanced study. Albert G. Snow, formerly at the Lake City (Florida) Research Center, joined our staff as center leader for the Virginia Pine-Hardwood Research Center. A complete roster of personnel as of January 1, 1953 will be found at the end of this report.

Ernst J. Schreiner, head of the Station's forest-genetics project, who returned in October after a year's study in Europe, has this to say about his tour in Europe--

"October 1951 to October 1952 was undoubtedly the most educational year of my life. In these 12 months Mrs. Schreiner and I covered approximately 30,000 miles by car from northern Sweden to the Isle of Capri. I had an opportunity to see and study poplar culture and research, forest genetics, and general forestry under the guidance of local research men and practical foresters in every country east of the Iron Curtain except Finland and Ireland. The fact that I speak fluent German and that Mrs. Schreiner handles Italian and Spanish with equal ease was of tremendous help from both the social and professional angles.

"Since my return the most frequent question has been 'What are your general impressions of Europe?' I won't attempt to answer that here, but I'll sketch my general impression of European progress with poplar, forest genetics, and general forestry.

"The importance of poplar in Europe is amazing to an American forester. Practically every country is planting poplar in steadily increasing quantities. Everywhere one now meets poplar growers, poplar foresters, and poplar researchers. In Germany, France, Italy, and even in Spain, there are some well-to-do farmers who derive more profit from their poplars than from all their other crops combined.

"Within the last few years there have been occasional reports by Americans on forest-genetics research in Europe. In my opinion, these have been too one-sided in the emphasis placed on the genetics research in Sweden. Their descriptions of the Swedish work are accurate: there is much excellent work under way there. But there is also much--and equally excellent--basic and applied forest-genetics research in almost every other country in Europe.

"My impression of general forestry in Europe is that it is extremely varied. Forest management and even silviculture can differ widely in the same region. Tradition and local economic factors, rather than biological requirements, are most frequently the reason for such differences in practice. In some places even forest research is strongly biased by silvicultural tradition, and too strongly circumscribed by an economy based on local tradition.

"During our year in Europe, I took more than 1,000 colored stereo photos to illustrate talks on poplar, forest genetics, general forestry, arboretums, gardens, and tourist attractions."

PILOT-OPERATION STUDIES

FOUR YEARS AGO the Station embarked upon a program of pilot-operation studies aimed at answering the question: "Will these practices that look so good in small plots and sound so promising on paper really pay off when applied in the management of a forest? And if so, at what intensity of application?" Intricately designed experiments using treatment areas ranging upwards from 20 acres were begun on seven of the Station's experimental forests. Cuttings and other treatments are, therefore, on a realistic small-commercial scale.

Despite their relatively small size the operations have encountered a number of unforeseen difficulties. This is a common occurrence in pilot-plant research in industry. Stumbling blocks or hurdles have arisen--and have been overcome--in labor supply, equipment, weather, markets, transportation, and similar fields. Cuttings are, accordingly, somewhat behind original schedules, but not discouragingly so. Revision of instructions on record-keeping for the pilot-operation studies will reduce some of the cumbersome research routine. The general effect should be to streamline and speed up the work.

These pilot-operation studies are not short-term limited researches, and conclusive results may not be achieved quickly. But indications, ideas, and probabilities are coming out of the work already. For example, at a number of the experimental forests, improvement harvest cuts made in accordance with good silviculture have proved profitable, or at worst have been made at small investment.

On the Bartlett Experimental Forest a cut of 613 cubic feet per acre (made up of 2,000 board feet of logs and 3.5 cords of pulp and boltwood) was made at a cost of $13.67 per cunit (100 cubic feet, solid wood) delivered at roadside where the material was worth $21.40 per cunit. The difference, $7.73, was the margin for stumpage, profit and risk, supervision, insurance, taxes, compensation, and other overhead costs. This cut was largely an improvement cut, taking out considerable mature and overmature paper birch and beech.

Cuttings for mine timbers are notoriously bad; normally the practice is to cut all usable material with no regard whatever for the growing stock left to produce the next crop. Pilot-operation cuttings on three compartments suggest that such a procedure is poor business in regard to immediate returns as well as to the longer term interests of landowner and

forest management. The compartments were cut to 8-, 12-, and 16-inch diameter limits respectively. The higher diameter limits maintain larger growing stocks and permit correspondingly shorter cutting cycles. They also increase the net return per unit of material handled, as is shown below:

Diameter limit (Inches)	Gross returns per M. bd. ft. (Dollars)	Logging cost per M. bd. ft. (Dollars)	Net return per M. bd. ft. (Dollars)
8	28.55	16.61	11.94
12	30.70	14.20	16.50
16	30.97	12.98	17.99

Improvements in logging practice on the pilot operations result from a form of "operational research," a continual questioning of the reasons for doing jobs in the customary way, and seeking new and better ways. How improvements come about step by step is illustrated by the experience of the logging crew on the Fernow Experimental Forest.

On the very first cutting on the forest the men hired were experienced with the 2-man crosscut saw; so the work was organized on that basis. When the first power saws were obtained they too were designed for 2-man operation, so the 2-man felling crew persisted. And it held over for a while after the light 1-man power saw was introduced on the job. One man handled the saw, the other wedging, limbing, marking log lengths, etc. Compared with the 2-man crosscut saw this organization doubled the efficiency of the men. But test runs showed that one man working alone with a 1-man saw at felling and limbing was $2\frac{1}{2}$ times as productive as when serving in a 2-man crosscut crew. Allowing for depreciation and maintenance on equipment, one man working alone with a power saw now cuts logs for 45 percent of the cost of cutting them with a 2-man crosscut saw.

Sound principles for skid-road location, construction, maintenance, and protection are also becoming apparent from the experimental logging on the Fernow Experimental Forest. Applied with forethought and planning, these principles can reduce skid-road costs and hence skidding costs in logging.

- Use low gradients in the lower, more accessible reaches. Steeper grades can be used in the upper ends of subdrainages where cuts (and site productivity) are less and there is little likelihood of converting the skid road to truck road later.

- Break grades occasionally, avoiding long straight grades.

- Stay out of stream channels. Skidding in stream channels damages water values and increases tractor maintenance costs.

- Go slantingly up slopes, not straight up and down.

- Use bridges or culverts over minor streams and drainages, thus avoiding lost time in mudholes and reducing equipment-maintenance costs.

- Avoid rock ledges; they are expensive to cut through.

- Build from the top of the logging chance downward, thus using bulldozers more efficiently.

- Give the skid-road surface a slight outslope when finishing construction with the bulldozer.

- The needs of future cuts can often be met at small expense by modifying the skid-road system needed for the current cut.

These principles, intelligently applied, will bring about skid-road systems that permit the use of tractors and logging arches and sulkies; and so will make possible tree-length skidding--with bucking at the landing or loading point--to obtain highest quality logs. Such road systems can be easily and cheaply put in usable condition for use at the next cut, or can be readily converted to truck roads at low cost later if that is desired.

CHEMICAL DEBARKING

This process, developed by industry, is proving so popular that the Station is undertaking it on the pilot-operation studies, so we can more satisfactorily answer inquiries we receive. The recommended practice is to apply a solution of sodium arsenite to the wood exposed by a bark girdle made during the normal sap-peeling season. It seems best to avoid cutting into the wood when removing the bark. This can be done by "bumping" the bark off with the head of a light poll ax.

The rate at which trees can be treated with the chemical is a point of interest in our work so far. On the Penobscot Experimental Forest a three-man crew selected, girdled, and applied the chemical to 53 cords of hardwood trees at the rate of 1.9 man-hours per cord. The trees ranged from 6 to 16 inches in diameter. An ax and bark spud were used to make the girdles and the solution was applied with a paint brush. A gallon of solution treated about 16 cords of peeled wood. On the Pocono Experimental Forest nearly 6,000 trees, with a volume of 52,507 cubic feet, were treated. Several crew organizations were tried but it generally worked out best, with the few men employed, to have each man do

his own girdling and applying of solution. The trees were mostly small in size and a hand ax proved handiest for bumping the bark off. Solution was applied with a brush.

None of the treated areas on the experimental forests have been cut as yet; so we do not have our own evaluation of the effectiveness of this method in loosening the bark.

FARM FOREST STUDIES

Studies of productivity and income from farm woods under good management continue to show that fair to good wages can be earned by harvesting products from improvement cuts. Hourly earnings are of the magnitude of 90 cents to $2.00. Most of the material being removed in the first cuts is so poor in quality, however, that no stumpage can be credited for it.

For example, a poorly stocked "woodlot" on the Penobscot Experimental Forest yielded 47 cords of rough pulpwood from dead and dying trees at a net return of $308.05--or $0.91 per hour for labor--after allowing for operating expense, taxes, and 3 percent interest on the value of land and timber. On the Fernow Experimental Forest the average wages earned in three annual cuts was $0.91 per hour also. There two "farm woods" are being studied, one with poor second growth and the other with somewhat better quality older trees. Earnings from the better tract average $1.12 per hour.

The first cut on the Bartlett "farm woods" of 43 acres yielded products having a gross roadside value of $2,865.39, or $66.36 per acre. This cut, which amounted to about 4 cords per acre, was heavier than later cuts will be, for it removed more than the expected growth. Although essentially an improvement cut, it was distinctly profitable, having paid wages of $2.25 per hour after allowances for equipment costs, taxes, stumpage, management costs, interest on investment in land and growing stock, and for profit and risk.

These results should be encouraging to those who feel that the farm forest can be fitted effectively into the farm work schedule. On the experimental forests the farm woods logging is done with relatively simple equipment by small crews to simulate farm conditions. In most instances the first cuts in previously unmanaged tracts remove low-quality trees, capable of yielding wages but not profits and stumpage. The cuts are therefore not attractive to loggers who normally purchase stumpage for their operations; the margin is too narrow.

SILVICS

Those of us who grapple with the day-to-day problems of industry wonder, sometimes, how researchers get drawn into some of the seemingly unimportant studies they report upon. Here is an example.

A large and profitable turning industry grew up in New England based upon extensive stands of excellent white birch. In the last decade or two, however, more and more plants have found their raw-material supply diminishing. White birch wasn't reseeding itself. Various reasons were advanced for this failure, such as improved fire protection, selective cutting and high-grading, birch "die-back," and others.

So the first step toward better management of white birch and rebuilding the resource for an industry seemed to be to find out what controls regeneration of white birch. That required observation of seedlings from time of germination on to learn why some die and others survive. When such studies were begun we found immediately that no one seemed to know, for sure, how to tell blackberry seedlings from birch seedlings, nor how to tell seedlings of the birches one from another. Learning how to identify the different seedlings didn't take long, yet progress toward the main objective stopped until a small botanical study was completed.

Relatively few people will ever use the information, and it certainly won't save the white birch turning industry, but we now know that:

- If the stems of the tiny seedlings are smooth, they are grey birch.
- If the stems have scattered minute spines, they are blackberry or raspberry seedlings.
- If the stems are distinctly pubescent (fuzzy) on the upper part, the seedlings are either white or yellow birch.
- If the leaves and stem have a wintergreen flavor, the seedlings are yellow birch.

An experiment in seedbed and related requirements of white birch on the Bartlett Experimental Forest showed that undisturbed litter practically precludes establishment of seedlings even with abundant seed supply, but if the litter is removed seedlings readily become established on the humus or mineral soil. Partial removal of the litter by a very light fire helped slightly, but the difference in number of established seedlings (over undisturbed litter) may have been due to sampling alone.

These results are subject to further check, for they were obtained from a small experiment employing milacres in an opening made in a white birch--red maple--aspen stand.

The preference, or requirement, of the birches for mineral soil seedbeds was confirmed by study of the kinds of seedlings found on the mounds of earth turned up by 104 trees windthrown in the 1938 hurricane on the Bartlett Experimental Forest.

Of the white birch seedlings that became established on the windthrow hummocks following the hurricane and have survived until now, 84 percent are on the "edge" or "under side" of the turned-up root system. Seventy percent of the surviving yellow birch seedlings are in these positions. Beech and sugar maple, in contrast, have survived best on the "upper" or litter side of the upturned root systems and in the depression left by the uprooting.

NATURAL REGENERATION

A large proportion of time and attention devoted to forest-management research is necessarily spent on study of the reproduction of species and stands. Until methods are devised to assure prompt and effective reproduction, forest "management" is certain to be haphazard, chancy, and hence unattractive as a long-time business enterprise. Other conditions must be met also to make forest management a successful business, but as the problems of getting new timber crops started are solved that element of risk is removed.

In general the problems met in getting natural reproduction are concerned with seed production, with seedbed requirements and preparation, with germination and early survival, with competition from unwanted vegetation and methods of evading or avoiding it, and with the requirements of seedlings for light, moisture, and nutrients. Progress is made and reported, therefore, along such lines.

Contrary to fairly widespread belief, Virginia pine seed production appears to be periodic or possibly cyclic. Seed traps on an area with abundant seed trees left after cutting on the Beltsville Experimental Forest showed seedfalls of 75,000, 24,000, and 3,000 viable seeds per acre in 1950, 1951, and 1952, respectively. The prospects for the 1953 cone crop, even allowing for normal losses, are at least five times as great as the 1952 crop. Some of the confusion as to regularity of cone production in Virginia pine probably arises from the persistence of the cones. They may stay on the trees for as much as 25 years according to counts and observations made at Beltsville.

In the South, burning is widely accepted as a method for preparing a favorable seedbed for loblolly pine. And studies in pond pine have shown that fire can aid in regeneration of that species also. An experiment to check the applicability of summer fires in regeneration of loblolly and pond pines on the Eastern Shore of Maryland was begun in 1951. The entire area was cut over, leaving abundant seed trees. Seedbed treatments consisted of random plowing with a small fire plow, summer burning alone, and summer burning with dragging a stump around to stir up the soil and litter. The burning treatments were generally better than plowing as to number and distribution of new pine seedlings and as to effect in reducing the number and vigor of hardwoods. Plowing was, however, distinctly better than no treatment other than logging.

The 10 seed trees per acre left on this experiment to assure an adequate supply of seed provided an average of 179,000 loblolly and pond pine seeds per acre in 1951. On 3 of the 4 plots in the study the number of seeds ranged from 200,000 to 204,000 per acre. On the fourth plot only about half that number fell, judging from the seeds caught in seed traps.

In the Pocono Plateau section of Pennsylvania, where repeated wildfires have permitted scrub oak to usurp and occupy large areas, one of the many treatments being tested to find ways of reclaiming those areas to forest production is designed to obtain natural reproduction of pitch pine from the surviving trees of that species. Lanes 8 feet wide, radiating out from seed trees, were cleared of scrub oak with a bulldozer to provide a mineral soil seedbed and to eliminate competition. The seed trees were mediocre to poor as seed sources, yet seedlings have become established at the rate of about 800 per acre of bared soil within 100 feet of the seed trees. The stocking fell off sharply at greater distances, but the method holds promise as a means of reducing the size of the planting job ahead.

ARTIFICIAL REGENERATION

While there will doubtless be numerous opportunities to convert scrub oak stands to useful species by natural regeneration, the area that will require planting is so large that inexpensive but effective methods for doing the job must be found.

In 1950, partly for comparison with the results of planting in bulldozed furrows, three species were interplanted in small openings in the scrub-oak cover on the Dilldown Watershed. Red, jack, and pitch pines were planted among low brush species such as blueberry that were present in the openings.

When the plantings were examined in 1951 the observers judged that most of the trees would be unable to withstand the competition of the low brush and would probably die. This year, however, observers gave more than 80 percent of the trees still living a fair to good chance to succeed. If that proves to be true, some 70 percent or more of the trees planted will survive. Planting in the small openings, and with only moderate survival, would yield spotty and irregular stands; but, considering the savings on site preparation, this might appeal to some owners as a method of getting skeleton stands established.

No cheap and completely satisfactory method has yet been found for preparing scrub oak sites for planting. During the past year a "root rake" was added to the list of hand tools, plows, bulldozers, rototillers, and chemicals that have been tested for that purpose. The "root rake" consists of large, heavy teeth fastened to the lower edge of a bulldozer blade. The teeth are to get under stumps, root crowns, and root mats and lift them out of the ground. The root rake worked rather well but proved to be a little more expensive than the cost goal tentatively adopted for such work. With a 10-foot rake on a D-6 Caterpillar tractor, clearing alternate 10-foot strips, the cost per acre was nearly $20 at $10 per hour for machine and operator. In use the rake leaves more topsoil on the cleared strip than a bulldozer does, but removes more organic material and topsoil than the rototiller, which conserves it all. The strips prepared last fall with the rake will be planted in the spring of 1953.

In 1949 a study was begun on the Hopkins Experimental Forest of methods of preparing very dense stands of wild spiraea for planting with trees. The most effective method, from the standpoint of survival and growth of the planted trees 4 years later, was through harrowing with a weighted "bog harrow." It chopped up the spiraea bushes and root mat and turned under much of the organic matter, conserving it. Burning the spiraea, ripping it off with a bulldozer, and removing a small patch for each tree by hand, resulted in survival and height growth better than no treatment--but not as good as harrowing.

European larch has made the best height growth, followed by red pine, Norway spruce, and red oak. Quite a few of the larch, however, have made practically no height growth and are stunted and bushy, a behavior pattern observed in scrub-oak conversion studies also. The red oak has been so consistently and severely eaten back by rabbits that it really shouldn't be ranked at all. Survival of the larch was only 56 percent, but that of the other three species was 70 percent or more, which is satisfactory.

CULTURAL OPERATIONS

Measures for controlling the composition or structure of the growing stock that do not yield merchantable products are generally regarded as being appropriate only for very intensive levels of forestry. This view arises largely because the financial value of such cultural measures has not been proved. For some investments of this nature the final test of profitability cannot be made until the timber crop is harvested, as for example whether the value of a pure pine crop justifies the money spent on releasing pine seedlings from hardwood sprouts. But for most of the stand conditions in the Northeast the financial evaluations are not as urgently needed as knowledge of just what measures can be used effectively to control the composition, structure, spacing, form, and growth rates of the widely diverse stands in the region.

Studies in this general realm are not stressed in the Station's forest-management research, but the experiments under way yield helpful information from time to time.

Following a 1938 heavy salvage cutting of old-growth trees damaged by glaze in 1936, a set of plots was installed on the Kane Experimental Forest to study the effect of mowing back advance reproduction, both large (up to 2 inches d.b.h.) and small (less than 1 inch d.b.h.). In 1952 a tally of the dominant trees on quadrats 4 milacres in size showed that black cherry was favored over sugar maple and beech by the mowing of both sizes of reproduction. But even on the check or unmowed plots it dominated a third or more of the quadrats. The form of the cherry is medium to good where small advance reproduction was mowed back, but where the larger saplings were mowed most of the cherry stems are of poorer form. Such mowing has, however, been found rather too expensive for general use.

Fire is commonly prescribed as a treatment to favor pine over hardwoods at the time of regeneration of mixed stands in southern New Jersey. Repeated light winter fires before final regeneration of stands serve two principal purposes: to prepare a seedbed favorable for pine, and to reduce the number and vigor of hardwood stems competing with the pine seedlings. Results from two sets of plots reveal that the effectiveness of the fires in reducing hardwood competition is dependent in part on the age of the hardwoods.

The two sets of plots had been burned five or more times prior to being clear-cut except for seed trees in the winter of 1946-47. Since then pine seedlings have become established at rates ranging from 3,400 to 4,800 per acre,

on the various plots. Before being cut, the hardwoods (chiefly oaks) on one set of plots were 52 to 77 years old. On the other set they were 24 years old.

The sprouts that developed after cutting the younger oaks are much more of a problem than those from the older stand. They are more abundant, have grown taller, and occupy more milacre quadrats. The success of the pine regeneration has, as might be expected, been in inverse relation to the vigor of the oak sprouting. Where the oaks were older and sprouting was less vigorous, the pine seedlings are now 3 to 4 feet tall and are dominant on a little more than 60 percent of milacre quadrats. Where the competition is tougher from the more vigorous sprouts from younger oaks, the pines are only 2 to 3 feet tall now and dominate only 13 percent of the milacre quadrats.

The prospects are, therefore, that an owner who wants to convert pine-oak mixtures to pure or nearly pure pine must plan on some measures such as poisoning of stumps, or cutting of sprouts, in addition to prescribed burning to control hardwoods. And the cost of these additional measures is likely to be greater for young stands than for older ones.

Commonly, as happened on the Massabesic Experimental Forest following the 1947 fire, white pine seedlings and those of the birches and other hardwoods all start together. Normally the hardwoods quickly outgrow the pines and dominate the site. How to maintain pine in the stand at reasonable cost is a problem that bothers many owners. Studies undertaken on the Massabesic, where the reproduction is now 5 years old, are beginning to cast light on the subject.

For example, the number of hardwood stems within a radius of 18 inches from the pine seedlings affects height growth of the pine. If there are only 5 competing hardwoods the pine grows 9 inches in height; if 6 to 8 hardwoods, 7 inches; 10 hardwoods, a little less than 5 inches pine growth; and if there are 15 or more hardwoods within 18 inches of it a white pine seedling will grow only 3 inches or less in height per year.

In another exploratory study 60 white pine seedlings selected at random were given full release by cutting competing hardwoods. The average growth of the 15 tallest seedlings was 4.80 inches in 1948 and that of the 15 shortest was 2.42 inches. After release, however, the taller seedlings grew about 3 times as fast as the small ones, and by 1952 had grown 22.61 inches as against a total of 8.42 inches average for the short group.

The first-year response of released white pine seedlings is a thickening of the current year's leader and the formation of more buds as compared with unreleased seedlings. This seems to

constitute a "getting set" for accelerated height growth and crown expansion beginning the second year.

Prevalence and destructiveness of the malady known as "birch die-back" lends interest to results of a 20-year-old study of the reaction and behavior of yellow birch and paper birch following a partial cutting. The decadence of birches after logging is spectacular and generally recognized. It occurred on the treated plot, and in 20 years some 20 percent of the trees left on the thinned plot died. But 30 percent died on the undisturbed plot. Rather more (20 percent) of the reserved dominants and codominants died on the cutover plot than did their counterparts on the check area (12 percent). The thinning, however, seemed to be helpful to the intermediates, for only 60 percent died on the thinned areas as compared with 75 percent on the check area. In the suppressed class the difference was even greater.

Although the proportion of dominants and codominants that showed decadence was higher on the cut plot than on the uncut, a much higher ratio of affected trees recovered on the thinned area. So, in spite of higher mortality and more apparent early decadence on the partially cut plot, the net growth rate of yellow birch on the treated plot was about twice that on the untreated area at all times during the 20-year period since cutting.

Apparently partial cutting had little or no effect on condition of crown or growth rate of paper birch. Until quite recently paper birch showed no noticeable effects of cutting operations. During the last 5 years this species showed increasing signs of decadence and some mortality on both plots. This is normal for 75-year-old paper birch in the locality.

In the White Mountains, where the beech scale and associated Nectria disease are established, a rapid buildup of the infestation and resulting loss of large beech can be expected. On the Bartlett Experimental Forest the scale was first observed in an old-growth stand a few years after it was lightly cut over between 1933 and 1937. Nectria was discovered on the plots shortly after that and by 1944 some trees had begun to die of the disease. During the first 5 years after the cutting very few beeches died. In the second 5 years the rate of death loss was about a third of the growth on the residual beeches. In the third period, however, the volume of the trees that died was greater than the growth of the residual stand and the "ingrowth" to the stand. And the prospects are that this trend will continue. When the scale is established and the infestation is building up, forest managers should plan early operations in the beech or be prepared to accept the losses that seem sure to occur.

SILVICIDES

Since the discovery several years ago that some of the synthetic growth hormones killed plants when applied in dosages heavier than minute, and that some were selective in action, there has been a great deal of experimentation in their use. Manufacturers of the chemicals, schools, agricultural experiment stations, right-of-way maintenance companies and many others have conducted more or less well-designed studies. Published results have, however, been so conflicting that no well-defined practices can be worked out from the literature with reasonable assurance of accomplishing any desired objective. Commercial advertising of the material has stirred up a great deal of interest among laymen who in turn have asked the Station for information on specific problems.

So, to obtain more of the information needed, a number of the research centers have begun studies in the use of Ammate and 2,4D and 2,4,5T and related substances. The studies are chiefly local checks of published information or are of an exploratory nature rather than thorough-going research of a fundamental nature. For example, the National Forest administration requested our help to determine whether spraying with the silvicides could be used to prevent or control the growth of roadside vegetation better or more cheaply than the customary mowing. Accordingly, a test was designed to compare several formulations of the silvicides, the effect of season of application, and several methods of applying the solutions.

All of the treatments on the mowed road shoulders generally killed all species to the ground. The more susceptible species were largely eliminated by all treatments, but a considerable proportion of the root systems of plants of the more resistant species survived.

Applications in April on dormant stubble were least effective. October treatments gave the highest percentages of complete kill. Of the summer treatments, the June series was consistently more effective than the August one. In the summer series of tests, differences between oil and water solutions were insignificant.

Ammonium sulfamate was less effective than a mixture of 2,4D and 2,4,5T. 2,4,5T alone seemed to be more effective than the mixture, but the comparison wasn't direct. An experimental preparation, 2-methyl-4-chlorophenoxyaceticacid, showed no particular merit in these tests, either alone or when added to other formulations.

One- and two-percent solutions of 2,4,5T in oil sprayed on the bases of saplings gave practically 100 percent kill; water solutions gave only scattered kills. The mixture of 2,4D and 2,4,5T in oil basal sprays also gave good kills but not the clean sweeps achieved with 2,4,5T.

No treatment killed briars 100 percent, but 2,4,5T at 1 and 2 percent strength in oil and water eliminated 70 to 90 percent of the canes. June applications were most effective. Addition of TCA (sodium trichloroacetate) to a water solution of the mixture of 2,4D and 2,4,5T made it as effective on briars as 2,4,5T alone when applied in July.

Of the species abundant enough to yield good observations:

- The most resistant were red and sugar maples, elderberry, blackberry, and bush honeysuckle.
- Ash, mountain maple, and striped maple were less resistant.
- Beech suckers were killed generally.
- Spruce and fir were killed when the foliage was completely wetted, but if a portion of the top was missed it survived.
- The most sensitive species were yellow and white birches, willow, and alder.

Operational time and cost studies on the Fernow Experimental Forest disclosed that poisoning trees with ammonium sulfamate in cups chopped into the base of the lower trunk required twice as much time as girdling 1 inch deep with a power saw. And since the sulfamate costs more per tree than power-saw maintenance, the difference in total cost is even greater than the time difference. Girdling with a single row of hacks was even cheaper than use of the power saw; but with a double row of hacks was a little more expensive.

The trees treated in this experiment were culls or of undesirable species; and quick, complete kills with no sprouting were desired. The ammonium sulfamate was about four to five times as effective as girdling in quickly killing the trees. It also greatly reduced sprouting. Whether this quick killing and lessened sprouting is worth the extra cost will depend somewhat on the final effectiveness of the girdling.

On the Massabesic Experimental Forest ammonium sulfamate applied in November and December was found much less effective than a mixture of 2,4D and 2,4,5T in killing oaks and maples. The sulfamate was applied in cups chopped in the bases of the trees; the 2,4D-2,4,5T mixture was applied as a basal spray in

oil solution. On the Fernow Experimental Forest, sulfamate applied during the growing season was almost twice as effective in killing the trees as was reported from the Massabesic. Resprouting of killed trees was negligible in both places.

Sometimes a seemingly good thing turns out to be a two-edged sword. The silvicides 2,4D and 2,4,5T turned out that way in two small experiments. In one, the scrub oak and other brush surrounding small openings on the Dilldown Watershed unit were basally sprayed in early spring and trees were planted in the openings about 3 to 6 days later. Most of the planted trees died, although there was good survival in check plantings adjacent. In the second experiment, on the Massabesic Experimental Forest, a joint of stove pipe was placed over white pine seedlings to shield them while surrounding hardwood stems were basally sprayed in the spring. Many of the white pines died and the growing tips of practically all were severely injured. In both experiments the silvicides were in oil solutions.

The studies were not designed to disclose how the silvicides got onto the trees, but speculation suggests that the solutions may have rubbed on to the clothing or hands of the tree planters as they walked through the brush; and that spatter, drip, or touching of the stove pipe may have transferred some solution to the white pines. Another possibility is that the silvicides volatilized slowly and the fumes settled on the susceptible seedlings. The oil solutions were used especially to retard volatilization and hold the silvicides in place for several days.

The answer to the difficulty on the planting site seems to be to arrange for a lapse of several weeks between poisoning and planting. In the white pine experiment, protective covers that can be left in place for some time are being tried.

TREE BREEDING

PROGRESS ON THE STATION'S program of research in forest genetics was curtailed somewhat by the absence of Dr. E. J. Schreiner on a year of study in Europe. But even during his absence cooperation with other agencies was expanded and strengthened, continuity of studies was maintained, and progress was reported in several publications.

Three of the research centers continued their field tests of 250 selected clones of "cottonwood" hybrids. The hybrids are showing an exceedingly wide range in growth rate in the tests. Maximum growth exceeds 7 feet per year and the poorest about 1 foot per year in height. Distinct differences are showing up also in reaction to wetness of soil and site quality. In this respect, the current extensive tests confirm indications from earlier restricted studies, namely, that the hybrids require good soil if their growth potential is to be realized. On graded strip-mine spoil banks in West Virginia the hybrids were a failure at the end of 1 year of testing.

A number of clones that were resistant in Maine are proving susceptible to canker diseases such as Dothichiza and Septoria when planted in Massachusetts and Maryland.

No successful substitute has been found for thorough preparation of planting sites for the poplars or for first-year cultivation when unrooted cuttings are planted. With good preparation and care, however, survival is usually excellent.

Cuttings of poplar hybrids were sent to cooperators in Ohio, Michigan, and Wisconsin. The cuttings were planted in tests exactly like those being made by the Station's research centers. Measurements and data to be furnished by the cooperators will fit in with the analysis of those from the centers to give wider coverage and applicability to the results.

The New York Conservation Department also became a cooperator on the forest genetics work during the year. The facilities of the Saratoga nursery were made available to us for growing stock from control-pollinated seed of spruce and other genera that do poorly at Philadelphia and Beltsville because of climate.

Controlled-pollination work was continued during the year. Spruces in the Philadelphia neighborhood bloomed well and more crosses were tried in this genus than ever before. Of the 10 successful interspecific crosses we have made, 7 are between species occupying adjacent ranges on the same continent. Here is further indication that crossable species must be closely related.

The 1951 pine interspecific crossings (the seed matured in the fall of 1952) were moderately successful, particularly those on Japanese black pine females. Most of the eastern white pine female parents dropped all their cones, possibly because of insect damage.

In the birch plantation on the Standing Stone (Pa.) Experimental Forest gray birch is doing very well, black and yellow moderately so, and paper birch poorly. That is about what would be expected from the geographic ranges and soil requirements of the species. With one exception (black X paper birches) the hybrids in the plantation are intermediate between their parents. Such performance by hybrids is rather common.

Racial crosses within species hold considerable promise of yielding "hybrid vigor" or other superior characteristics in the progeny, and are much more generally successful than interspecific crosses. Some "interracial" crosses in white pine and sugar maple were made during the year and two related studies were begun. An exploratory study was made on the Massabesic Experimental Forest to see whether there seems to be any genetic difference between white pine stands in their resistance to the white pine weevil. Analysis by some statistical techniques not commonly used in forestry indicates that there are real differences present. While the results of this study must be confirmed by orthodox progeny tests, it does provide a better starting point for selection work than we have had heretofore.

So far we have had much less success in breeding sugar maples than the soft maples. In the search for superior breeding stock for intraspecific crossing, study of sugar content of sugar maple sap was continued during the spring. Of 1,500 trees tested, about 90 percent had between 1.6 and 3.0 percent sugar in the sap. The "sweetest" tree fell in the 6.1 to 6.5 percent class. The distribution of trees by sugar content percentage classes is such that the chances of finding a tree with 7.0 percent sugar are about 1 in a million.

FOREST INSECT INVESTIGATIONS

Report from the New Haven Station of the
Division of Forest Insect Investigations,
Bureau of Entomology and Plant Quarantine,
335 Prospect Street, New Haven, Conn.

DURING 1952 THE New Haven Station of the Division of Forest Insect Investigations continued studies and surveys of the spruce budworm, white pine weevil, Matsucoccus sp. on red pine, beech scale, and balsam woolly aphid. A study was conducted in New Hampshire to determine the loss in merchantable volume of white pine timber attributable to the white pine weevil. An appraisal survey was made to determine the susceptibility to gypsy moth outbreaks of woodlands in the eastern half of the United States. A virus disease was distributed from an airplane for control of the European pine sawfly. Investigations were continued of the newer insecticides and methods for applying them. A host plant-insect index has been prepared for Miscellaneous Publication 657 "Insect Enemies of Eastern Forests."

Spruce Budworm

Aerial surveys in Maine revealed spruce budworm defoliation on a total of 416,000 acres in two separate areas located in northern Aroostook County. Two degrees of defoliation were recorded. Of the total area affected, 90,000 acres showed "continuous defoliation" while "scattered defoliation" appeared on 326,000 acres. Detailed studies in permanent plots located in northern Maine indicate that natural control factors continue to hold the budworm population below the level of economic damage. These factors include winter mortality, parasites, birds, mites and spiders.

There is a serious outbreak of the spruce budworm in north-central New Brunswick, which covers an area of about 5,000 square miles. Approximately 190,000 acres were sprayed last June by airplanes at the rate of 1 pound of DDT per gallon per acre. Plans are under way for spraying a much larger area in 1953. Studies conducted in 1952 in the sprayed area, in cooperation with Canadian entomologists, indicated an average reduction in budworm population of 99.83 percent. The average deposit which effected this high mortality was 0.318 pound of DDT per acre. The New Brunswick infestation constitutes a serious threat to Maine forests because of the possibility of mass moth flights across the border.

White Pine Weevil

More than 200 permanent white pine weevil survey plots were established in the Northeast in cooperation with the New England States, New York, and New Jersey. The purpose of the plots is to obtain information on annual fluctuations of white pine weevil populations throughout the region.

Aerial photographs in color at a scale of 1:800 may be used for obtaining rather accurate estimates of weeviled trees. Counts of weeviled trees on aerial photographs of a 500-acre area showed 10.97 percent of the trees weeviled as compared to 10.84 percent from ground counts.

Studies of the bionomics of the white pine weevil indicated that spring emergence of adults is correlated with maximum duff temperatures and maximum air temperature. This information will be helpful in timing spray applications to control weevil adults in early spring. Collections of weeviled pine leaders from permanent sample plots in New York and Connecticut showed an increase in weevil population over that of 1951. Examination of weeviled leaders indicated that birds were important predators on weevil grubs. In general, parasitization was low. Winter mortality of adults ranged from 32 to 65 percent in the plots.

Experiments are now under way to reclaim severely weeviled stands by the "thin and spray" method. This method consists of cutting all or most of the severely damaged trees and protecting the remaining trees by spraying. Trees up to 16 feet in height may be protected with present spraying equipment. Airplane spraying experiments with DDT, conducted in cooperation with the New York Conservation Department, resulted in 97 percent reduction in weeviling, using a 4-pound dosage applied at the earliest sign of weevil activity (April 24 this year).

At the instigation of the White Pine Weevil Committee of the New England Council a study was conducted in New Hampshire to obtain information on the loss in merchantable volume of white pine timber attributable to the white pine weevil. Plots established by the Northeastern Forest Experiment Station for the forest survey of New Hampshire were used as sample plots for this study.

Plans are being made at the Massabesic Experimental Forest and the Harvard Forest to study the effect of different degrees of release of white pine on weevil attack.

Matsucoccus Sp. On Red Pine

This unidentified scale insect continues to kill red pine at an alarming rate in the Bridgeport, Conn., area. A survey of

this area, conducted in cooperation with the Connecticut Agricultural Experiment Station, showed that about 45 square miles are infested. Crawlers of the scale are apparently spread by the wind, for they were caught on tanglefoot screens at a distance of 1/4 mile from infested trees. Attempts to establish the scale on white, jack, pitch, and Scotch pines have been unsuccessful. The only known host is red pine. All attempts to control the insect with insecticides have been unsuccessful.

Beech Scale

Studies are being conducted in cooperation with the Northeastern Forest Experiment Station at Bartlett, N. H., to attempt to control the beech scale by silvicultural practices and by insecticides. Four 5-acre plots have been treated silviculturally to study the effect of different degrees of thinning on beech scale populations. An experiment is under way to determine if beech scale infested trees can be kept alive by controlling the scale on the lower boles of the trees with a DDT spray applied with a knapsack sprayer.

Balsam Woolly Aphid

Plots have been established on the White Mountain National Forest to determine the damage to balsam fir caused by the balsam wooly aphid. Individual trees of pole- and sawtimber size, as well as reproduction, have been numbered and annual records of aphid attack and tree condition will be taken. It is hoped that this study may give some clue to the silvicultural control of this insect.

Gypsy Moth

The New Haven Station and the Gypsy Moth Control office in Greenfield, Mass., have collaborated with William P. House in his studies of the economic damage caused by the gypsy moth in New England during the period 1933-1952. Mr. House has completed a report on his studies entitled "Appraisal of Damage by the Gypsy Moth in New England, 1933-1952."

In order to obtain information on the potential damage which the gypsy moth might cause if it should spread to the south and west, an appraisal survey was conducted in the eastern half of the United States to determine susceptibility of woodlands to gypsy moth outbreaks. Information obtained from the experiment stations of the U. S. Forest Service was a most valuable aid in conducting this survey. Personnel from this Station, the Gypsy Moth Control Project, the U. S. Forest Service, and the New York Conservation Department participated in the survey. A special report on their findings has been prepared.

European Pine Sawfly

Studies were conducted in cooperation with the New Jersey Department of Agriculture to control the European pine sawfly, Neodiprion sertifer, by the airplane application of a virus disease. The virus disease, which is of European origin, was supplied by Canada in 1951 for small-scale tests with a knapsack sprayer.

Outstanding results were obtained in these tests. In 1952 the virus spray was applied from an airplane on an 18-acre area in New Jersey, heavily infested with the sawfly. Complete control of the insect was obtained. The spray was applied at the rate of about 2 gallons per acre, each gallon containing approximately 2.5 billion virus polyhedra. This is believed to be the first attempt in this country to control a forest insect by the dissemination of a virus from an airplane.

Spraying Equipment

A new type spraying device attached to a helicopter was used in dispersing DDT spray for control of the elm bark beetle, vector of the Dutch elm disease. Equally good results were obtained in controlling the elm bark beetle as with a hydraulic sprayer. The helicopter had certain advantages over ground equipment; namely, application was more rapid, spray run-off was eliminated, and DDT deposit was heavier in the tops of the trees. Experiments conducted to compare the new spraying device, which is in effect an airborne mist blower, with conventional nozzle-boom apparatus showed that the new device gave a wider swath and produced a much greater number of droplets per unit area.

Improvements were made in a light-weight 6-hp. multi-purpose mist blower. The machine weighs only 195 pounds and may be mounted on a pick-up truck, small tractor, or trailer. It has been used successfully to control insects on low shade trees, nursery stock, fruit trees, grapes, blueberries, and vegetables.

Host Plant-Insect Index

Because of many requests, a host plant-insect index has been prepared for Miscellaneous Publication 657, "Insect Enemies of Eastern Forests." The host plants and various insects are listed, in alphabetical order, with the insects grouped as bark and phloem borers, bark feeders, leaf feeders, sucking insects, etc. This index will be published as a supplement to Miscellaneous Publication 657.

FOREST DISEASE INVESTIGATIONS

Report from the Division of Forest Pathology, Bureau of Plant Industry, Soils and Agricultural Engineering, 360 Prospect Street, New Haven, Conn.

WORK HAS CONTINUED on the disease susceptibility of hybrid poplar clones, the role of fungi in causing excessive mortality of birch, the effect of decay upon pulpwood floatability, the possibility of silvicultural control of the scale-Nectria disease of beech, and the preparation of indexes of forest tree diseases. In addition, greater emphasis has been given to studies of European larch canker in North America, Phomopsis canker of white pine and other conifers, and oak wilt.

Disease Susceptibility Of Hybrid Poplar Clones

Hybrid poplar clones that have shown evidence of resistance to canker caused by Septoria musiva are being tested at the Hopkins Memorial Forest, Williamstown, Mass., for resistance to Dothichiza populea, another canker-producing fungus which infects species of poplar as well as hybrids in the United States and Europe. The final results from inoculations with this fungus will be obtained in the spring of 1953.

Observations regarding conditions that may influence infection by these two fungi were made in Massachusetts, Connecticut, Wisconsin, and Minnesota. At Madison, Wis., and Rochester, Minn., both fungi were abundant in experimental plantation. Infection of twigs and branches following weakening of the trees by unfavorable growing conditions was caused by Valsa sordida and Valsa nivea. The latter fungus was found on young shoots that had apparently been weakened by winter injury.

The poplar leaf-blotch fungus, Septotinia populiperda, was rare at Williamstown, Mass., and Madison, Wis., occurring only in the oldest plantings and causing no serious injury. Leaf infection by Septoria musiva and Marssonina species was abundant in all plantings inspected during the summer of 1952.

Experiments in controlling diseases caused by parasitic fungi that might be transmitted by spores on dormant cuttings were conducted during January to March 1952. Solutions of mercuric chloride in 70-percent alcohol, Bordeaux mixture, and chlorox were tested. The effect of the solutions on the viability of fungus spores and on the production of roots and shoots from the cuttings was tested by culturing, on artificial media,

buds and lenticels from treated cuttings and by planting treated cuttings in sand in the greenhouse. A 4-second dip of individual cuttings in a 5-percent solution of mercuric chloride in 70-percent alcohol, without rinsing in water, showed a high percentage of sterile buds and lenticels. Cuttings thus treated rooted readily, provided they were not held in storage more than 3 weeks. Cuttings stored for a longer period showed some evidence of injury from the residual mercury.

Die-Back Of Birch

The investigation of twig fungi associated with die-back in crowns of diseased yellow and paper birch and fungi in the roots and soil about these trees, was terminated with the testing of healthy 5-year-old potted saplings of both yellow and paper birch under greenhouse conditions with a root fungus. The soil in which the saplings were growing was heavily inoculated in 1952 with spores and mycelium of a fungus tentatively identified as a species of Cylindrocarpon. The fungus had been frequently isolated from the roots of die-back birch. To date there has been no evidence of die-back in the saplings as a result of the soil inoculation.

Of the 138 birch survey plots established previously, in cooperation with the Division of Forest Insect Investigations, Bureau of Entomology and Plant Quarantine, 70 plots were reexamined in 1952, including all of those in Maine, and one-third of those in New Hampshire, Vermont, and New York. Analysis of the survey data discloses that the rate of deterioration of birch stands has decreased markedly until today birch can be regarded as at least holding its own, if not actually improving. On the basis of the survey plots, yellow birch is in worse condition than paper birch and is responding less quickly to present more favorable site conditions.

Decay In Red Spruce And Balsam Fir Pulpwood
In Relation To Its Floatability

Field work on this study is completed and partial analysis of the data indicates that the principal factors affecting floatability are species, decay, position of bolt in tree (butt, midcrown, or top), and degree of seasoning.

Sinkage losses were greater in balsam fir than in red spruce but the effect of many other factors operating on the two species has not been evaluated. In both species sinkage losses were higher for bolts with some decay than for sound bolts. Bolt position strongly influenced floatability, the higher the origin in the tree, the greater the sinkage losses. Seasoning increases floatability. The sinkage rate in fresh-cut logs was five times greater than in those seasoned from July to the following spring. In the unseasoned bolts, sinkage losses were about equal for peeled and

rough bolts; but in the seasoned bolts, there was about ten times as much sinkage in the rough as in the peeled bolts. This indicates that peeling and seasoning are extremely beneficial in increasing floatability.

Silvicultural Control Of Scale-Nectria Disease Of Beech

(In cooperation with the Division of Forest Insect Investigations, Bureau of Entomology and Plant Quarantine, the White Mountain National Forest, and the Bartlett Experimental Forest.)

The experimental approach to this problem was outlined in the previous annual report. All plots have now been established and plans are now complete for the participation of the four interested agencies in plot maintenance and the securing of annual progress records. It will be several years before the effect of any of the treatments on the disease can be evaluated.

Forest Tree Disease Indexes

This project has proceeded according to plan. About 60,000 cards have been added to the index, including references to forest tree diseases from North and South America, Europe, Asia, Africa, and Australia. Special reports on particularly serious diseases are being prepared for submission to other Federal agencies and for publication in technical journals.

European Larch Canker In North America

The destructive trunk and branch canker of larch plantations in western Europe caused by Dasyscypha willkommii was discovered on imported nursery stock of larch from Great Britain in 1927 in Massachusetts. The disease occurred commonly on European larch and rarely on Japanese larch. A search for larch canker was made in many European larch plantations as far West as the Lake States but it was found only in the Massachusetts area where nearby native and planted larches were carefully scrutinized. More than 3,700 diseased larches were subsequently removed and burned by 1935. The causal fungus was not discovered on our native eastern American larch (tamarack).

Previous to its actual discovery in this country, this foreign forest tree pest had been reported in the literature as already present in North America. Moreover, the larch-canker parasite was attributed to attack hosts other than larch, including planted Douglas-fir in the Northeast. Intensive studies carried on at New Haven in the 1930's demonstrated these reports to be erroneous and the only known site for the occurrence of true Dasyscypha willkommii to be the area of introduction in Massachusetts. In this country the parasite was restricted in its host range to Larix and Pseudolarix (golden larch).

To determine whether the foreign pathogen had been eradicated successfully in this country 17 years ago, an intensive re-examination of larch in the Massachusetts-introduction area is now under way and will be completed by mid-summer of 1953.

Phomopsis Canker Of White Pine And Other Conifers

A canker of eastern white pine, known as "Phoma disease," girdles and kills small branches and trunks of white pine reproduction or occurs on the main stem of pole-size white pines, usually in injuries at the nodes caused by improper pruning. Associated with the canker is the fungus, Phomopsis strobi, which occurs on a number of conifers other than pine. It is identical with the canker-fungus, Phomopsis pseudotsugae, which is parasitic on planted Douglas-fir in Great Britain and elsewhere in western Europe. A recent study of Norwegian cultures conducted at New Haven has shown that Phomopsis strobi is also identical with the blue-staining fungus, Discula pinicola, on pine and spruce logs in northern Europe. Further studies of this disease are planned.

Oak Wilt

Oak wilt is now well established in eastern United States but is not known east of the Susquehanna River or north of Erie County in Pennsylvania. In the East all states where oak wilt has been found are either carrying on or are planning state-wide suppression programs. The Division of Forest Pathology is assisting state and private agencies in surveys to discover oak wilt infections and in research to determine the best methods of local control. In 1952 extensive surveys were made in New Jersey, New York, and southern New England without finding any infections in the area covered.

In Pennsylvania, tests were made to determine the feasibility of using helicopters to apply tree poisons from the air to isolated or inaccessible oak wilt infections. At least one full season must elapse before these tests can be evaluated.

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WATERSHED STUDIES

THE IMPORTANCE OF ASSURED quantities of good water to rapidly expanding metropolitan and industrial centers continues to occupy an important place in affairs of the Northeast. Conditions in the Delaware River Basin exemplify the importance of water needs and also the awareness of states, communities, and individuals of the need for maintaining stable yields of water through the year.

Estimates of future water needs in the Delaware Basin have been projected through the year 2,000. These estimates indicate that use of Delaware River water will more than double during the next 50 years. Streamflow measurement on the Delaware River has been carried on for a considerable number of years, and shows that the total yield of water by the Delaware is more than sufficient to take care of any foreseen needs.

However, these records show that a large portion of the annual water yield is discharged during high-water periods when it cannot be used efficiently and is lost to the ocean. At the same time, during the period of the year when low-water flow occurs, discharges reach such a low ebb that many water users cannot be supplied adequately. Thus it is evident that if present and future users are going to be adequately satisfied, measures must be taken that will tend to hold back water during

the winter and spring and make more water available for the late summer and fall periods.

The City of New York is nearing completion stages in constructing impounding reservoirs and diversion works intended to divert an average of 440 millions of gallons of water per day from the headwaters of the Delaware. This diversion was authorized by a ruling of the U. S. Supreme Court in 1932.

The Interstate Commission on the Delaware River (Incodel) has prepared a plan for development of the waters of the Delaware by means of a series of large impounding reservoirs and diversion works. This plan is intended to retard runoff during high-water periods and maintain better flow during dry seasons, at the same time providing additional water for New York City, northern New Jersey, and the Philadelphia-Camden area. According to the plan, water will be available for all uses anticipated at least to the year 2000 and minimum flows will be maintained at a high enough level to assure navigation in the lower reaches of the river up as far as Trenton, New Jersey. These higher minimum flows will also prevent the movement of salt water from the Delaware Bay up the river. The plan has been approved by the state governments of New York, New Jersey, and Delaware. Pennsylvania is making a special investigation before taking any action on the plan.

In the meantime, New York City has petitioned the U. S. Supreme Court for permission to divert up to 350 millions of gallons per day more than has presently been authorized. This petition would not be pressed if the Incodel plan were put into operation. Pennsylvania and New Jersey are opposing the New York petition.

Thus, conflicting water interests are becoming evident.

Approximately 50 percent of the total area of the Delaware River Basin is forested. The largest part of this forested area lies in the upper half of the drainage basin. The upper half of the watershed receives the greatest precipitation and produces the greatest amount of water. Most plans for development of increased water supplies for domestic and industrial purposes look to the upper basin as a source of supply. The forested portion of the Delaware Basin is also an important producer of a number of forest products, is a very important recreational area, and constitutes an important wildlife area.

During 1952, forest-influences studies were carried on in the Northeast to determine the effect on water values of a number of forest conditions and forest-management practices.

DELAWARE-LEHIGH EXPERIMENTAL FOREST

The Delaware-Lehigh Experimental Forest was established in 1948 to determine water behavior for a watershed covered largely by a dense growth of scrub oak, and then to determine the effect of converting the vegetative cover to timber stands of commercially valuable species. During the past 4 years, measurements have been made on the 1,530-acre Dilldown Watershed to calibrate it under its present cover conditions. These measurements are intended to determine day-to-day values for precipitation, runoff (streamflow), interception, water loss in the riparian zone, evapo-transpiration loss, changes in groundwater storage, changes in soil-moisture storage, and changes in snow storage.

Some of these factors may be determined by direct measurement. Others must be evaluated for part of the time, when direct measurement is impossible, by development of regression relations with some other measurable factor. It is felt at present that one more year of measurements will complete the calibration period. At that time steps will be taken to establish a timber growth of desirable species as rapidly as possible. Measurements will be continued to determine the effect on water relations of this change in vegetative cover.

Methods of determining some of the hydrologic factors and regression relationships that have been established can be described briefly.

Riparian Water Loss

Riparian water loss, the loss due to evapo-transpiration in the streambed zone, is the difference between base groundwater flow and daily streamflow during those periods when streamflow is not affected by storm runoff. Since streamflow is affected by storm flow for 2, 3, or 4 days after each storm, no direct measurement of this loss can be obtained on probably the majority of the days during the season such loss occurs. On these days it is necessary to estimate the loss, preferably by its relationship with other factors.

Using days in which direct measurement could be obtained, riparian water loss was related, first, to base groundwater flow. This obviously is a measure of the amount of water available for evaporation and for use by the vegetation in the stream bed zone. The correlation was found to be highly significant.

Next, weather conditions, temperature and humidity, would logically affect the amount of evapo-transpiration. Saturation deficit, a factor combining temperature and humid-

ity, was related to loss; and it also was found highly significant. Numerous forms of this factor were tried and the best estimate was obtained by the following:

$$SD = \frac{4\ (SD_1) + 2\ (SD_2) + (SD_3)}{7}$$

in which SD_1 = saturation deficit of the day in question; SD_2 = saturation deficit of the previous day; and SD_3 = saturation deficit 2 days previously.

The two variables (base flow and saturation deficit), used together in a multiple regression equation, indicated losses very well, but an interaction of the two indicated values even closer. The final equation derived is:

$$RWL = 0.0054BF \times \log 100SD - 0.0044$$

in which RWL = daily riparian water loss, in inches; BF = daily base groundwater flow, in inches; and SD = saturation deficit as derived above.

It is proposed that this equation be used for all days when base flow is greater than daily streamflow. But when daily streamflow is the higher--during and after storms--it will be substituted for base flow in the above equation. In this case, daily flow will provide a much better estimate of available water than base flow.

Interception

Interception of rainfall by the vegetative cover was determined by measuring the amount of rainfall that lands on the vegetation, determining the amount that falls through the canopy, and measuring the amount of water that runs down the stems; the difference between rainfall and the latter two items is net interception. Interception determinations were made for both the shrub growth (largely scrub oak), which occupies about 90 percent of the watershed, and also for the high forest of mixed hardwoods and conifers with an understory of rhododendron, which is found adjacent to the stream channel and occupies slightly less than 10 percent of the total area. Interception losses for both vegetative types were found to be closely correlated with the amount of precipitation for each storm. These relationships are shown below:

$$IL = 0.043P + 0.010, \text{ for scrub oak}$$

$$IL = 0.138P + 0.019, \text{ for high forest}$$

in which IL = net interception loss in inches, and P = total storm precipitation in inches.

Evapo-Transpiration Losses

Evapo-transpiration losses for that portion of the watershed other than the riparian zone were determined by analysis of daily soil-moisture measurements. Measurement of soil moisture was made by means of Colman fiberglas units placed in vertical series through the soil profile at several locations in the watershed. Soil-moisture losses from one day to the next were calculated for periods during which all gravitational soil moisture had already drained out.

An analysis was then made to determine the relationship, if any, between these moisture losses and certain climatic and soil factors, so that it might be possible to calculate evapo-transpiration losses without recourse to the direct-measurement method. This analysis showed that a linear relationship existed between daily evapo-transpiration loss and the logarithm of the average daily saturation deficit. It also showed that the regression coefficient of this relationship was related to the total amount of sand through the soil profile. Thus, for four different locations in the watershed, evapo-transpiration equations were obtained as follows:

$$L = 0.248 \log(1{,}000\ SD) - 0.323$$

$$L = 0.189 \log(1{,}000\ SD) - 0.245$$

$$L = 0.119 \log(1{,}000\ SD) - 0.154$$

$$L = 0.131 \log(1{,}000\ SD) - 0.171$$

in which L = daily water loss in inches, and SD = average saturation deficit for the day in inches of mercury. With these relationships established, evapo-transpiration losses may be computed for each day of the season when the vegetation is in full foliage.

Water Balance

A daily accounting for the Dilldown Watershed is maintained for all water entering the watershed, all water leaving the watershed, and changes in water stored within the watershed. This accounting is checked by means of a water balance wherein inflow equals outflow plus or minus storage changes. Table 1 shows monthly totals for the various factors involved for June to September, water-year 1949-50.

Note that table 1 covers the period when some 70 to 75 percent of the total annual water loss occurs. Analyses are now being carried on to determine similar relationships for the dormant season.

Table 1.--Water balance of Dilldown watershed, in inches

Item	Depth on watershed area			
	June	July	Aug.	Sept.
Incoming water (precipitation)	3.19	5.62	2.26	3.16
Outgoing water:				
Streamflow	2.08	1.85	0.78	0.58
Interception	.30	.45	.17	.24
Riparian loss	.33	.27	.11	.02
Evapo-transpiration	3.06	2.85	2.60	1.42
Total outgoing	5.77	5.42	3.66	2.26
Change in storage:				
Ground water	- .97	- .36	- .69	- .46
Soil moisture	-1.21	+ .20	- .43	+ .89
Total change	-2.18	- .16	-1.12	+ .43
Total *	3.59	5.26	2.54	2.69
Difference **	-0.40	+0.36	-0.28	+0.47

* Outgoing ± storage change. ** Incoming -outgoing ± storage change.

FERNOW EXPERIMENTAL FOREST

Watershed studies have been started on the Fernow Experimental Forest in West Virginia to determine the effect of various levels of timber cutting upon water behavior. During 1952, measurements were made in five small watersheds to determine differences in hydrologic characteristics that occur between these areas prior to any logging activity. This calibration period will be continued until differences between the areas have been reliably determined; then four of the watersheds will be logged according to four standards of cutting practices. The fifth watershed will be maintained undisturbed as a control.

Studies have also been started on the Fernow Experimental Forest to determine and evaluate some of the more important factors that affect erosion on logging skid roads and to devise methods for controlling it. Specific objectives are:

- To determine the effect of different grades and distances on erosion both during and after logging.
- To determine the effect of intensity of use on erosion.
- To determine the effect of soil factors on erosion.
- To devise methods of locating, constructing, and maintaining a logging skid road to minimize erosion.

Erosion measurements made during the first year of this study were used to develop an alinement chart in which the length and steepness of skid-road grade are the independent variables and the amount of erosion expressed in inches depth over the road surface is the dependent variable. Table 2 presents erosion data for different steepness and length of grade as determined from the alinement chart.

Table 2.--First-year erosion from skid roads, by grade and distance

Grade (percent)	Distance of skid road, in feet				
	50	100	150	200	250
	Inches	Inches	Inches	Inches	Inches
5	0.37	0.56	0.70	0.82	0.92
10	.46	.62	.75	.86	.94
15	.52	.68	.80	.90	.97
20	.59	.72	.83	.93	1.01
30	.70	.81	.92	.99	1.07
40	.80	.90	.98	1.05	1.11
50	.88	.97	1.04	1.10	1.16

Table 2 or the alinement chart from which it is derived may be used as a guide to determine the necessary spacing of water bars in order to keep erosion rates to any set minimum. This should be applicable to all parts of this mountainous area where topography, soils, and climatic conditions are similar.

Intensity of use is another factor that influences the amount of erosion. The more loads that are skidded out over a road, the greater the erosion. The increase in erosion with

increased use is a result of two factors. One is mechanical; as each load of logs passes, part of the soil is carried down the hill and part is compacted. The second reason is due to the nature of the subsoil material exposed: each succeeding load of logs continues to disturb the soil to a greater depth; the lower part of the soil profile is more susceptible to erosion because infiltration is slower and there is less organic matter at greater depths.

Table 3.--Soil loss from skid roads, by intensity of use

Intensity of use	During skidding	First 2 months after skidding
	Inches	Inches
Heavy		
#1	5.35	0.44
#2	2.05	1.06
Light		
#1	.77	.06
#2	1.28	.30
#3	.84	.14

Table 3 shows the great difference in erosion between roads that are heavily and lightly used, and also the great reduction in erosion that occurs after skidding operations have been discontinued.

These studies will be continued and supplemented to test various methods of after-logging care intended to reduce erosion. Results of these studies will be used to develop guides for the location, construction, use, and maintenance of skid roads, and after-logging care needed to keep erosion to a minimum and thus protect watershed values.

SNOW AND FROST STUDIES

Measurements of snow and soil freezing were continued through the second winter of observation. These measurements were made on 186 plots representing 22 land uses and forest conditions. The plots were located in Maine, New Hampshire, Massachusetts, New York, and Pennsylvania.

Analysis of data, which is only partially completed, has been concentrated on the determination of maximum snow accumulation and rate of melt for the different land uses and conditions. A comparison of maximum depths of snow at a time just prior to the beginning of the spring melt shows bare cultivated areas to have the least snow accumulation of any condition sampled. Areas covered by hardwood forest stands, both pole and saw timber, have the most; they accumulated an average of 2.7 to 3.0 times the depths on bare cultivated land. The relative snow depths are a good indication of the relative amounts of water stored under the different conditions sampled.

Analysis of melt rate as expressed in inches of water loss for those areas in New Hampshire near the Bartlett Experimental Forest show the bare cultivated areas to have the highest melt rate of the conditions sampled. Conifer-covered areas have the lowest melt rate; areas covered with hardwoods have a somewhat higher rate.

An analysis of melt rate from one condition (abandoned field with good natural reproduction) was made to determine the relationship between accumulated melt and accumulated mean daily temperature above 32 degrees Fahrenheit. This relationship was found to be:

$$M = 0.09T - 1.4$$

in which M = accumulated melt in inches of water loss, and T = accumulated mean daily temperature above 32° F. Correlation coefficient equals 0.943.

It is not known at present whether the temperature-melt rate relationship determined for the Bartlett area can be applied to other areas. Continued analysis of the snow and soil freezing data will determine what conditions tend to promote snow accumulation, retard snow melt, and reduce the amount of impervious soil freezing. Such conditions would be conducive to reducing runoff during the high-water period in the spring and would help to maintain higher flows later in the year.

FLOOD-CONTROL SURVEYS

THROUGHOUT 1952 THE Division of Flood Control Surveys has confined its work almost exclusively to the resources survey of New England and New York, which is being carried out by the New England-New York Inter-Agency Committee (NENYIAC). Concentration on this one activity resulted from the urgency placed on this task by the President, plus the necessary curtailment of other activities because of a reduction in operating funds and personnel. With the exception of two reports that were in review-draft stage, all other activities of the Division were placed in abeyance until either the NENYIAC survey is finished or more funds become available.

NENYIAC is charged with the task of inventorying the area and recommending plans for development of its natural resources. All bureaus of the Department of Agriculture are working through the Secretary's Field Committee to contribute to the plan for agricultural development, which is being prepared by the NENYIAC Agriculture Study Group.

It was decided early in the study that no attempt would be made to delineate separately that part of the program for improved land treatment which would contribute to flood-damage reduction. However, to secure proper integration between the various phases of the over-all program, it is necessary to have an estimate of the effect of the proposed land treatment on the water economy of the region and the concomitant benefits and costs.

The task of making such a hydrologic evaluation presented many problems. The large size of the area to be surveyed and limitations in time and personnel precluded the use of techniques that had been developed for smaller areas. Also there was little precedent for integrating plans prepared by groups with such diverse interests; so methods of analysis and evaluation used by the various bureaus and agencies had to be reconciled. Although some of the problems yet remain to be solved, much progress has been made.

Flood-control technicians of the Forest Service and the Soil Conservation Service, working as a unit, evolved techniques for making land-use and condition inventories and for evaluating the hydrologic effect of changes that will result from better methods of land management. Changes in the capacity of watershed lands to regulate streamflow are most effective in reducing flood peaks in the headwater areas. But as the tributary streams converge, these effects tend to become compensating and the percentage of peak reduction decreases. With the help of the Corps of Engineers, methods have been worked out for determining these cumulative effects and for routing the expected changes in stream-

flow down the river and through the structures proposed for major flood-control and hydro-power development.

The inventory of the agricultural phases of the project is finished. Hydrologic analyses and routing computations were begun in the fall and have been completed for 3 of the 16 rivers in the basin. Similar studies for the remaining basins are in various stages of completion. The report to the NENYIAC Flood Control Study Group on the hydrologic effects of the agricultural program in the Kennebec River basin has been completed. Reports for the other rivers are in process.

It is expected that the initial phase of the NENYIAC study will be completed by late spring and that draft reports will have been submitted to the NENYIAC for all river basins in the region. Upon completion of this phase, our work load on the New England-New York study should be lessened somewhat. When this relief does occur we will be able to resume work on the surveys of other watersheds.

THE FOREST SURVEY

Forest Inventory

FIELD CREWS SURVEYED 5,232,000 acres in 1952, bringing the total forest area surveyed in the Northeast to 46,059,000 acres. More than 60 percent of the total job is now done. New York was finished this year and became the fifth state in the region to be completely surveyed. Two other states--Pennsylvania and Connecticut--are more than 60 percent covered.

State agencies have been cooperating wholeheartedly; New York, Pennsylvania, and Connecticut furnished new aerial photographs. Office space has been made available as needed.

Type Maps

Field type mapping has been kept nearly current, and all areas surveyed will be mapped this winter. The final type map for West Virginia was drafted and colored this year.

Commodity Drain

All drain work has been completed in West Virginia and Maryland. Only a few office computations remain to complete the drain studies for New York.

Plans were drawn for obtaining drain estimates in Connecticut by use of duplicate aerial photography and the field work is approximately half done.

In Pennsylvania, a woods-utilization study is under way. The Station is helping the State prepare a plan for estimating commodity production. These production estimates will eliminate any need for a separate production survey by the Station.

Reports

The state statistical reports for Vermont and West Virginia were published. Unit reports for Western Maryland and for Forest District No. 7 of New York were also published. A report on a Maryland test of the "continuous-inventory forest-survey system" was issued in July.

The Central Maryland unit report and seven unit reports for West Virginia are being prepared for printing. Unit reports for three forest districts in New York, the Eastern shore of Maryland, and the Maryland state statistical report are being reviewed.

The New Hampshire analytical report is ready for editing.

FOREST ECONOMICS

ALTHOUGH MOST OF the effort in forest-resource investigations goes into the forest survey, a number of other studies were continued or begun during 1952.

In cooperation with Harvard University, the Station has continued analyzing the small forest owner's economic problems and opportunities. A report on economic possibilities from combining forestry and dairy farming for nine New England farmers is nearly completed.

New Hampshire Forest Policy

Last July Governor Adams of New Hampshire appointed a committee of forest-land owners and industrial representatives to recommend a forest policy for the State. At the Governor's request, the Station lent one of its staff to act as secretary for this committee. It also furnished background information about the forest situation in the State. The Committee's report, "Forest Policy for New Hampshire," was being printed at the close of the year.

Benefit-Cost Appraisal

Economic evaluation of benefits and costs resulting from land-use programs is an important step in program planning. The Station has been working with the Department of Agriculture's Field Committee in attempting to develop a realistic and useful method of appraising forestry proposals for the New England-New York Area.

Marketing Of Forest Products

Little is known about how timber grown on the numerous small forests in the Northeast is marketed. Yet such information is needed in order to understand how markets and marketing affect the forest resource and to determine how to bring about greater efficiency in forestry. Early in 1952 the Station and seven of the state agricultural experiment stations began to investigate this problem. The first phase of this project--a survey of present market practices--is now well under way. The Station (in cooperation with various other local agencies) has begun to gather enough similar data in the other five states to permit a regional analysis of forest-product marketing practices.

A survey of pole and piling production and markets, mentioned in our last annual report, has been completed. The report will be published in 1953.

In cooperation with the Maryland Department of State Forests and Parks, arrangements have been made to test log grades for southern pines growing in that State.

FOREST UTILIZATION

THE STATION'S Forest Utilization Service serves as a connecting link between the Forest Products Laboratory at Madison, Wisconsin, and the forest-products industries. It has three primary functions:

- To define and analyze problems in the utilization of timber and to determine the best approaches to solution of these problems.
- To bring regional utilization problems to the attention of the Forest Products Laboratory or other research agencies so that properly balanced and coordinated research programs can be developed.
- To aid the forest-products industries and timber growers of the region by bringing to them technical information and research results.

Designed to remove technical blocks to better utilization, this service also facilitates application of proper forest-management practices. And--although not a primary function--its work in coordinating research effort helps public and private agencies make efficient use of the limited resources they have to devote to forest-products research.

It is not possible to evaluate precisely the progress made in any one year as a result of Forest Utilization Service activities. Its three primary functions are not independent, and efforts on one function often yield results that can be credited to another. For example, information developed in a study in one field may become new research information that can be put to use in another field. And once a research project is concluded, it becomes the basis for promotional activities to put the results to use.

The work of the past year can be considered under three broad categories: problem analysis, new research activities, and promotional activities.

Problem Analysis

The Forest Utilization Service was especially active in studies of logging equipment. It played a major part in broad studies of logging equipment made for the National Production Authority. To keep informed on new developments, it maintained close contact with manufacturers of tractors, saws, and other kinds of equipment.

It studied the operations of a paper company that is developing an integrated utilization system designed to divert hardwood--normally used for pulp--to higher-grade uses. Improvement in organization and use of equipment and manpower were studied on another pulp company's operations.

The many experimental operations in chemical debarking were followed closely, especially the research work done by the Syracuse Research Foundation and the applications made by some of the larger pulp companies. Other developments studied included machinery for making compressed fuel from sawmill waste, a plant that makes insulating board and other products from waste, and a plant that makes semi-compreg.

Use of hardwood bolt material for dimension stock is another problem that was studied. One study was made in cooperation with the State University of New York's College of Forestry at Syracuse, in an effort to develop a plan for extensive research in this problem. The Forest Utilization Service also assisted a Forest Products Laboratory technician in a special study of mechanical aspects of bolter saw equipment and of small German gang-saws that may be helpful in breaking down bolt material.

Study of timber quality was continued. Station personnel took part in conferences at the University of North Carolina on problems of developing veneer-log grade specifications and at Purdue University on a standard method of handling quality index.

Several new installations of charcoal kilns in the Northeast were observed to evaluate the promise of new developments. And the operations of two marketing cooperatives--Connwood in Connecticut and the Otsego Forest Products Association in New York--were reviewed.

In addition, the Forest Utilization Service arranged for and participated in a clinic on wood preservation. This led to formation of a permanent organization, the Northeastern Wood Preservation Conference, which was organized to develop a coordinated research program in this important field.

New Research Activities

The Forest Utilization Service took part in a cooperative study--with the Northeastern Regional Research Laboratory and the Michigan College of Mining and Technology--on separating bark from chips of unbarked slab wood. It arranged for shipments of fast-grown European larch, to be evaluated as a source of pulpwood by the Forest Products Laboratory. It arranged for eastern white pine test material, sent to the Forest Products Laboratory for a study of effect of knottiness on pulp quality.

A significant study of air-seasoning of beech prompted by the Forest Utilization Service, was completed this year. This study, in cooperation with a Philadelphia tool manufacturer, was carried out by Forest Products Laboratory technicians. One of the distinctive aspects of this study was that quality of seasoning was judged by yield of product rather than by change in lumber grade.

Putting Research Findings To Use

In getting research findings put to use, the Forest Utilization Service acts to a certain degree in a consulting capacity. This is done through letters, by telephone, and by visits to mills. During the year hundreds of technical questions were discussed with operators of wood-using industries. Questions are answered directly or are referred to the Forest Products Laboratory.

The Station carries out this activity only on an incidental basis. With its limited personnel, it finds more ground can be covered by working through the numerous other agencies that carry on both research and promotional work in this field. The Forest Utilization Service gave special attention to this approach during the year. It has worked with the following organizations:

Northeastern Wood Utilization Council, Forest Products Research Society, Society of American Foresters, Keystone Dry Kiln Association and New England Dry Kiln Association, New

England-New York Inter-agency Committee, Northeastern Lumber Manufacturers' Association, Northeastern Loggers' Association, Northeastern Logger magazine, Vermont Forest Products Conference, Forest Service Log Grade Committee, Forest Service Equipment Development Committee, New England Council, Northeastern Wood Preservation Conference.

The Forest Utilization Service conducted three schools in timber-quality appraisal: one for the state forestry organization of West Virginia; one for the timber-scaling and -grading organization of a paper company in New Hampshire; and one for a mixed group consisting of lumbermen, timberland owners, and county foresters in New Hampshire.

Another promotional activity has been carried on in cooperation with the Northeastern Technical Committee on Utilization of Beech. Representing a number of forestry agencies in the Northeast, this group is preparing a series of 23 papers to promote better utilization of beech. Forest Utilization Service personnel serve as a steering committee, and the Station publishes the papers. One paper was published in 1951, and three last year. Several other papers, now ready for printing, will be published in 1953.

Station personnel also prepared material for the Society of American Foresters' proposed field manual (section on timber harvesting).

Another new project is a revision of the U. S. Department of Agriculture Farmers' Bulletin 2008, "Logging Farm Forest Crops in the Northeast." The initial edition has been exhausted, and demand for this information outside the Northeast has been large. At the request of the Department of Agriculture, the bulletin is being rewritten to bring it up to date and make it applicable nation-wide. Comments and suggestions have been gathered from extension foresters and forestry schools throughout the country.

by staff members and cooperators of the
Northeastern Forest Experiment Station

*Banks, Wayne G., and Ostrander, Myron D.
1952. THE SOUTHWESTERN MAINE FIRE AREA--FOUR YEARS LATER. Northeast. Forest Expt. Sta., Northeast. Res. Note 18. 4 pp. Upper Darby, Pa.

Re-study of the area burned in the 1947 forest fire showed that most economic effects of the fire have been so completely masked by other factors that they cannot be appraised separately. Stocking of reproduction has improved on areas that did not have adequate stocking of pole or saw timber after the fire. The heaviest stocking is in white birch.

Barraclough, Solon.
1952. A KEY TO FORESTRY IN NEW HAMPSHIRE: THE PREDOMINANCE OF SMALL FOREST OWNERSHIP. Forest Notes 16 (1): 3-6. (Soc. Protect. N.H. Forests.)

In New Hampshire, where 84 percent of the land area is forested, the forests are mostly in small tracts, held by some 35,000 owners. These small ownerships are a special problem because small private owners face obstacles to forest management that large owners do not encounter. Forestry services and educational efforts should be extended to reach and help these small owners.

1952. INPUT-OUTPUT DATA FOR FORESTRY ECONOMICS. New England Res. Council on Marketing and Food Supply, Ann. Proc. 1952: 38-42. Boston.

Input-output data that the economist can use in analyzing forestry problems and planning for production are hard to find. A survey of private ownerships and experimental forests in New England turned up very little usable data. The economist has a responsibility to let the physical scientist know what kind of input-output data he needs.

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* Copies or reprints available.

* Bethlahmy, Nedavia.
1952. WHY DO PLANTS WILT IN COLD WEATHER?
Ecology 33: 301-303, illus.

Studies of soil freezing, using the Colman soil-moisture meter, indicate that when a soil is frozen, the fiberglas units in the meter react as though the soil had been desiccated. A frozen soil is, physiologically, a dry soil. Concretely frozen soil is equivalent to a soil that is below its wilting point in moisture content. Thus a plant growing in frozen soil has no moisture available for growth; if it transpires, it will wilt.

* ----------
1952. A METHOD FOR APPROXIMATING THE WATER CONTENT OF SOILS. Amer. Geophys. Union Trans. 33: 699-706, illus.

Describes a procedure for calibrating fiberglas soil-moisture units and for preparing tables needed to convert resistance readings into inches of water.

* Bickford, C. Allen.
1952. THE SAMPLING DESIGN USED IN THE FOREST SURVEY OF THE NORTHEAST. Jour. Forestry 50: 290-293.

Sampling methods are designed scientifically to obtain the best accuracy possible for a fixed amount of money or to meet a fixed standard of accuracy at the least cost. The author describes the sampling design developed by the U. S. Forest Service in the forest survey of the Northeast. A similar design could be used in cruising small forest tracts.

* ---------- Chapman, R. A., and Caporaso, A. P.
1952. REPORT ON COOPERATIVE TEST OF "CONTINUOUS-INVENTORY" FOREST SURVEY SYSTEM IN EASTERN MARYLAND. Northeast. Forest Expt. Sta. 31 pp. Upper Darby, Pa.

New developments in airphoto forest survey were tested in eastern Maryland to determine if cubic-foot volume classes could be used instead of stand-size classes in stratifying the forest area; and if repeat airphotos (2 sets made with a time interval of about 10 years) could be used to estimate forest drain. As a result of the test, cubic-foot volume classes will be used in future surveys. Use of airphotos to estimate drain is promising and will be tested further.

Caporaso, A. P.
1952. THE FOREST SURVEY IN PENNSYLVANIA.
Penna. Forests 37 (350): 8-9, illus.

The present forest survey of Pennsylvania was begun in 1946. By 1952, field-inventory work was completed in

42 percent of the State's forest area. The author describes the methods used in gathering sample data: use of airphoto interpretation and field examination of sample plots, compilation of data, and preparation of forest-type maps and statistical reports.

*Cunningham, F. E.
1952. COVER CROPS NO SUBSTITUTE FOR CULTIVATION IN HYBRID POPLAR PLANTINGS: RESULTS AT WILLIAMSTOWN, MASS. Northeast. Forest Expt. Sta., Northeast. Res. Note 14: 4. Upper Darby, Pa.

Eight different cover crops, tried in plantations of five hybrid poplar clones, failed to keep out weeds and retarded growth of poplars. Brome and millet retarded poplar growth most, lotus and lespedeza least. Other crops used were lupine, soybean, wheat, and buckwheat.

Curry, John R.
1952. EVERYBODY LOSES IN WOOD ACCIDENTS.
Lumber Camp News 13 (9): 9.

An appeal to all persons connected with lumbering in the Northeast to work for improvement of the woods safety record. Woods foremen have a special responsibility to enforce the simple precautions that can often prevent a serious accident.

*---------- and Church, Thomas W., Jr.
1952. OBSERVATIONS ON WINTER DRYING OF CONIFERS IN THE ADIRONDACKS. Jour. Forestry 50: 114-116, illus.

In the winter of 1947-48, unusual and extensive damage to conifer foliage occurred throughout northern New York as a result of winter drying. The authors report observations and studies of this phenomenon made in the central Adirondacks during 3 years.

---------- and Church, Thomas W., Jr.
1952. WINTER INJURY OF CONIFERS IN THE ADIRONDACKS.
Northeast. Logger 1 (1): 10, 15, illus.

(See above.)

Dill, Henry W., Jr.
1952. AIRPHOTO INTERPRETATION INVENTORY AND PLANNING.
Jour. Soil and Water Conserv. 7: 81-84, illus.

The author describes an airphoto-interpretation method that was used in a study of the Allegheny River watershed to gather data about open land. Airphotos were used not only in inventorying the watershed, but also in planning land use. Their use cut down greatly the amount of field work.

Flick, Frances J.
1952. THE GRADING OF LOGS AND TREES.
Northeast. Forest Expt. Sta. 16 pp. Upper Darby, Pa.

A bibliography compiled by the U. S. Department of Agriculture Library for the Log Grade Committee of the Forest Service.

*Ford, H. F., and Williamson, M. J.
1952. COVER CROPS NO SUBSTITUTE FOR CULTIVATION IN HYBRID POPLAR PLANTINGS: RESULTS AT BELTSVILLE, MD. Northeast. Forest Expt. Sta., Northeast Res. Note 14: 1-4. Upper Darby, Pa.

Use of cover crops to obviate the need for cultivation was tested in five hybrid poplar clones at Beltsville. All the cover crops tested (buckwheat, cowpea, crotalaria, lespedeza, millet, rye, Italian rye grass, perennial rye grass, and soybean) inhibited the growth of the poplars.

Hart, Arthur C.
1952. A TABLE OF PRODUCTION RATES FOR CUTTING SPRUCE AND FIR PULPWOOD. Jour. Forestry 50: 557-558.

Presents a table of production rates (man-hours per cord) for skidded wood and stump wood, both rough and peeled, to assist the woods manager in planning cutting operations. The data are based on time studies of five commercial pulpwood operations. D.b.h. classes are used.

1952. A WRIST GUARD FOR PULPWOOD HANDLERS.
Northeast. Logger 1 (5): 37, illus.

Describes and gives detailed plans for a leather wrist guard for protecting pulpwood handlers from injury by a pulpwood hook. Made of a single piece of 1/8-inch harness leather 3 inches wide, the wrist guard has proved useful in pulpwood operations in Maine.

Holcomb, Carl J.
1952. A HISTORY OF THE MONONGAHELA NATIONAL FOREST.
Davis and Elkins Coll. Hist. Mag. 5: 29-34. Elkins, W. Va.

The area that now comprises the Monongahela National Forest is located in West Virginia along the mountainous part of the State, including 1,641,981 acres, more than one-ninth of the entire area of the State. The author reviews the various legislative attempts to create a National Forest, culminating in 1911 with the Weeks Law and subsequent Federal purchases of land.

*Holcomb, Carl J., and Bickford, C. Allen.
1952. GROWTH OF YELLOW-POPLAR AND ASSOCIATED SPECIES IN WEST VIRGINIA AS A GUIDE TO SELECTIVE CUTTING. Northeast. Forest Expt. Sta., Sta. Paper 52. 16 pp. Upper Darby, Pa.

On the hypothesis that vigor classes are a reliable guide to growth rate of yellow-poplar, the authors developed definitions of four vigor classes for individual yellow-poplar trees. The forest manager can use these in selecting the trees to leave when marking for a partial cutting. Vigor class is used as a guide to diameter and volume growth of individual trees; and the growth can be translated into increment in value.

*Hough, A. F.
1952. PRELIMINARY RESULTS OF RED PINE SEED-SOURCE TESTS IN NORTHWESTERN PENNSYLVANIA. Northeast. Forest Expt. Sta., Sta. Paper 49. 28 pp., illus. Upper Darby, Pa.

Seedlings representing 50 seed sources in the Lake States and Northeast were tested in plantations at Kane, Pa, to determine effect of geographic origin on seedling survival and growth. Detailed data of the results are presented. For planting in the northern Allegheny Plateau, the author recommends certain Lake States seed sources.

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1952. RELATIONSHIPS OF RED PINE SEED SOURCE, SEED WEIGHT, SEEDLING WEIGHT, AND HEIGHT GROWTH IN KANE TEST PLANTATION. Northeast. Forest Expt. Sta., Sta. Paper 50. 14 pp., illus. Upper Darby, Pa.

As part of seed-source studies at Kane, Pa. (see Hough, above), supplementary studies were made of relationships among seed source, seed weight, seedling weight, and height growth. Significant relationships were found between seedling weight and height growth at the Kane plantation, but attempts to relate these back to the seed sources in the Lake States were unsuccessful.

Hutnik, Russell J.
1952. IDENTIFICATION OF VERY SMALL BIRCH SEEDLINGS. Jour. Forestry 50: 558.

With the aid of a hand lens and a simple taste test, proper identification of birch seedlings that consist of the two cotyledons and one miniature leaf is possible. Paper birch seedlings are distinctly pubescent on the upper part of the stem, but gray birch seedlings have smooth stems. Yellow birch seedlings are also pubescent, but have a slight wintergreen taste.

Hutnik, Russell J.
1952. REPRODUCTION ON WINDFALLS IN A NORTHERN HARDWOOD STAND. Jour. Forestry 50: 693-694, illus.

Distribution of seedlings on the microsites of the uprooted areas at the base of windfalls was studied in New Hampshire. Very little reproduction was found in the depression caused by the uprooting (8 percent). The heaviest reproduction was on the upper surface of the uprooted area (42 percent); most of the seeds apparently were lodged before the blowdown occurred. Distribution is given by species.

Kidd, Walter J., Jr.
1952. A SMALL-TREE DIAMETER GAGE. Jour. Forestry 50: 220, illus.

Description of a diameter gage made of a notched piece of aluminum-magnesium alloy. Notches range from 0.6 inch to 4.55 inches. The gage has been found very useful, especially on 1- and 2-inch trees.

Little, S.
1952. SILVICULTURAL OBJECTIVES AND METHODS ON UPLAND SITES IN THE NEW JERSEY PINE REGION. Bartonia 26: 44-47. Philadelphia Bot. Club.

Present stand conditions vary widely, reflecting results of fires, cutting, and land-clearing. The most profitable stands are those composed of seedling pines never damaged by fire, and these could greatly increase the present growth of forests. Different management efforts directed toward establishing these stands are briefly described.

1952. EFFECTS OF FOREST FIRES ON UPLAND SITES IN THE PINE REGION OF SOUTHERN NEW JERSEY. N.J. Coll. Agr. Ext. Serv. Leaflet 100. 8 pp., illus.

Describes and illustrates effects of forest fires on pines and oaks in the New Jersey pine region. Hot, wild fires of the past have helped to shape the present forest stands. Today controlled light winter fires are being used silviculturally to encourage crops of seedling pines.

*Little, S., and Moore E. B.
1952. MECHANICAL PREPARATION OF SEEDBEDS FOR CONVERTING OAK-PINE STANDS TO PINE. Jour. Forestry 50: 840-844, illus.

Mechanical ripping or disking was found to be effective for preparing seedbeds favorable for pine in the oak-pine forests of southern New Jersey. However, such treatments are risky because of the uncertainty of catching a good seed crop. And, in the authors' experiments, none of the treatments assured dominance of pines over oak sprouts.

*---------- and Somes, H. A.
1952. POISONING HARDWOODS IN SOUTHERN NEW JERSEY. Northeast. Forest Expt. Sta., Northeast. Res. Note 16. 4 pp. Upper Darby, Pa.

Ammate and a commercial preparation of 2,4,-D and 2,4,5-T were tested on a small scale for controlling hardwoods that compete with more valuable softwoods. On upland sites, where oaks compete with the pines, the most promising treatment was use of ammate crystals on the edges of freshly cut stumps. On swamp sites, where white-cedar is the desired species, treatment of standing trees with ammate was promising.

*---------- Somes, H. A., and Allen, J. P.
1952. CHOOSING SUITABLE TIMES FOR PRESCRIBED BURNING IN SOUTHERN NEW JERSEY. Northeast. Forest Expt. Sta., Sta. Paper 51. 7 pp. Upper Darby, Pa.

Prescribed use of light winter fires as a silvicultural tool is still more art than science, and experience and skill are necessary for getting the proper intensity of fire. The fire-danger-rating system can be used as a general guide for choosing proper burning conditions, but the authors recommend a small test fire in case of doubt.

McGuire, John R.
1952. QUALITY TIMBER SUPPLIES IN THE NORTHEAST. Forest Prod. Res. Soc. Jour. 2 (3): 117-119.

Nearly 16 percent of the commercial forest land of the United States is in the Northeast, yet these forests do not provide even half enough wood to keep the local industries going. Quality or the lack of it, is the reason. Quality softwood supplies are very low. The hardwood situation is somewhat better, but the proportion of low-grade lumber is increasing--and industry continues to need high-grade material.

*McGuire, John R., and Wray, Robert D.
1952. FOREST STATISTICS FOR VERMONT.
Northeast. Forest Expt. Sta. 47 pp., illus.
Upper Darby, Pa.

Results of the forest survey of Vermont, including tabular data and a brief outline of the forest situation. Vermont, 63 percent forested, contains 3.7 million acres of commercial forest land. These bear more than 8½ billion board feet of sawlog material, more than half of it in sugar maple, beech, and yellow birch. Softwoods--mainly spruce and hemlock--account for a third of the volume.

McLintock, T. F.
1952. COST OF PRUNING RED SPRUCE IN NATURAL STANDS.
Jour. Forestry 50: 485-486.

Results of a time study on the Penobscot Experimental Forest near Bangor, Maine, presented to help the forest owner make a fairly reliable estimate of the cost of pruning red spruce trees in natural stands. Average cost was 14.8 cents per tree. White pine trees were found to be much cheaper to prune.

1952. PRACTICAL MANAGEMENT OF SPRUCE AND FIR--SOME OBSERVATIONS. N. Y. Forester 9 (2): 1-3. N. Y. Sect., Soc. Amer. Foresters.

Planned control over the future development of the spruce-fir forests is a practical aspect of forest management that is often overlooked. Considering cutting methods; cutting cycles; losses to disease, insects, and windthrow; advantages of marking; economic factors such as accessibility, labor, and markets; and site quality and the use of forest-management zoning, the author concludes that the benefits of planned control are so great that the owner cannot afford not to adopt better cutting practices where economically feasible.

1952. PRACTICAL MANAGEMENT OF SPRUCE AND FIR.
Northeast. Logger 1 (5): 15, 35.

(See above.)

*McQuilkin, W. E., and Little S.
1952. DEER REPELLENT FAILS TO PROTECT PINE SEEDLINGS.
Northeast. Forest Expt. Sta., Northeast. Res. Note 15. 4 pp. Upper Darby, Pa.

A commercial deer repellent was tested in New Jersey (on pitch and shortleaf pine) and in Pennsylvania (on white pine). It was applied as spray. The authors conclude

that the repellent may be effective for short periods, but for protecting pines from browsing deer over winter it is not effective.

*Marquis, Ralph W.
1952. FOREST YIELD TAXES.
U. S. Dept. Agr. Cir. 899. 50 pp.

Yield-tax laws have been adopted by 19 states in efforts to find an equitable basis for taxing forest land. The author discusses the principles of the yield tax, and describes the specific provisions of yield-tax laws that have been applied. In summary, he suggests what a good yield-tax law should do, and outlines general requirements for a good law.

1952. THE CONDITIONS UNDER WHICH FORESTRY WILL PAY IN NEW ENGLAND. New England Res. Council on Marketing and Food Supply, Ann. Proc. 1952: 51-53.

Forestry will pay in New England where the land is reasonably productive and physical conditions (site, climate, exposure to risk, and accessibility) are not unfavorable--if management is based on the productivity of the land and the biological condition of the site, and is directed toward the products adapted to the site and to future markets. Highest returns will come from integrated operations that can utilize or market all products for their highest use or value. Forestry will pay best where financial institutions are favorable. Property taxes must not be unreasonable, long-term credit may have to be available, and insurance may be necessary.

*Northeastern Forest Experiment Station.
1952. ANNUAL REPORT, 1951.
Northeast. Forest Expt. Sta. 75 pp., illus. Upper Darby, Pa.

A report on progress of the Experiment Station's research program. One trend noted is an increasing recognition of the importance of tree quality; the problem of improving quality is discussed. Personnel and publications are listed.

1952. SURVEY REPORT, MERRIMACK RIVER WATERSHED. NEW HAMPSHIRE AND MASSACHUSETTS. Northeast. Forest Expt. Sta. 43 pp.; appendix 84 pp. Upper Darby, Pa.

Final report on a flood-control survey of the Merrimack River watershed, describing the watershed problems and recommending a remedial program. For administrative use only.

Northeastern Forest Experiment Station.
1952. SURVEY REPORT, SALT RIVER WATERSHED. KENTUCKY. Northeast. Forest Expt. Sta. 47 pp.; appendix 89 pp. Upper Darby, Pa.

Final report on a flood-control survey of the Salt River watershed, describing the watershed problems and recommending a remedial program. For administrative use only.

*Ostrander, Myron D.
1952. A HANDY AID FOR HARDWOOD LOG GRADERS. Northeast. Forest Expt. Sta., Northeast. Res. Note 13. 3 pp., illus. Upper Darby, Pa.

Describes a visual outline of the U. S. Forest Products Laboratory's hardwood log-grading system and presents a detailed full-scale sketch that can be reproduced on any conventional scaling stick. Designed as an aid for training log graders, this log-grade rule has been used extensively by Experiment Station personnel and has proved a time-saver.

*Ritter, George J.
1952. THE CHEMISTRY AND CHEMICAL UTILIZATION OF BEECH. Northeast. Forest Expt. Sta., Beech Util. Series No. 4. 17 pp. Upper Darby, Pa.

Technical data on chemical composition of beech wood, bark, and beechnuts; and discussion of chemical utilization of beech wood for wood sugars, molasses, yeast, and alcohol, and destructive-distillation products such as gases, pyroligneous acid, and tars. Chemically modified woods, and use of beech for such products, are also discussed.

*Rogers, Earl J.
1952. LARGE-SCALE AIRPHOTOS TESTED IN FOREST SURVEY, PROVE UNSATISFACTORY. Northeast. Forest Expt. Sta., Northeast. Res. Note 12: 1-3. Upper Darby, Pa.

Continuous-strip large-scale airphotos, taken with the Sonne camera, were tested for possible use in forest-survey work. Quality of the photos was good, but photo scale was variable. At present the large-scale photos seem to have no advantage over conventional small-scale photos for forest-survey work.

*Simmons, Fred C.

1951. HARVESTING THE FOREST CROP IN THE NORTH-EAST AND THE LAKE STATES. In IMPROVEMENTS IN LOGGING TECHNIQUES IN THE UNITED STATES. Proc. United Nations Sci. Conf. on Conserv. and Util. of Resources vol. 5: 234-242, illus.

Describes the postwar mechanization of logging work in the Northeast, with the widespread adoption of mechanical labor-savers such as the chain saw, crawler tractor equipped with winch and sulky, cable skidding, loading devices, and logging trucks. The techniques used in adapting these machines to Northeastern forest conditions are discussed.

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1951. SAWMILL TECHNIQUES.
Proc. United Nations Sci. Conf. on Conserv. and Util. of Resources vol. 5: 217-223, illus.

Describes various types of saws (circular saw, bandsaw, sash gang-saw) and accessory equipment used to produce lumber and other wood products. Among the newer developments is the experimental use of gang chain saws to rip logs into lumber. Techniques for sawing out the maximum amount of top-grade lumber are discussed briefly.

1952. HARVESTING FUELWOOD IN STICK FORM.
Forest Prod. Res. Soc. Proc. 5 (1951): 183-186, illus.

One of the main reasons for the declining use of wood for fuel is the high price, due mainly to the cost of traditional harvesting methods, which may require 2 or 3 man-days per cord. With modern harvesting methods and equipment this can be reduced to a fraction of a man-day per cord.

1952. NORTHEASTERN LOGGING INDUSTRY AND NATIONAL DEFENSE.
Lumber Camp News 13 (12): 6-7, 21, illus.

A Nation-wide survey of logging equipment and manpower shows that Northeastern loggers have almost twice as much money invested in equipment per million feet of annual production as western loggers. Northeastern loggers have led the way in developing methods and equipment for logging light and scattered stands.

Simmons, Fred C.

1952. LUMBERING EQUIPMENT PROBLEMS.
Forest Prod. Res. Soc. Jour. 2 (1): 52-55.

Shortages in equipment and parts (crawler tractors, large truck tires, bulldozer blades, planer knives, etc.) and shortages in labor create some bottlenecks in lumber production in the Northeast. Some operators report difficulty finding enough stumpage to keep in operation. But in general the industry is pretty healthy.

1952. REDUCING DAMAGE ON MECHANIZED JOBS.
Northeast. Logger 1 (3): 7, 20.

A "hot-rod" tractor operator in the woods is as dangerous to the future timber stand as the "hot-rod" automobile driver on the highways is to other motorists. Seven practical rules are suggested for reducing damage on mechanized logging jobs.

Sims, I. H.

1952. HARD HATS STANDARD EQUIPMENT ON FOREST SERVICE JOBS. Northeast. Logger 1 (1): 9.

On its experimental logging jobs, the Northeastern Forest Experiment Station provides protective hats for its men to wear. They were reluctant to adopt this innovation. But after two or three accidents in which the hard hats prevented serious injury, the woods workers liked them.

*Trimble, George R., Jr.

1952. A METHOD OF MEASURING INCREASE IN SOIL DEPTH AND WATER-STORAGE CAPACITY DUE TO FOREST MANAGEMENT. Northeast. Forest Expt. Sta., Sta. Paper No. 47. 8 pp. Upper Darby, Pa.

Studies of forest soils indicate that depth and water-storage capacity of shallow forest soils can be increased through forest management that maintains well-stocked stands. Effect of management can be measured by determining organic-matter content and pore space of soils found under different forest-stand conditions. Methods of measuring these effects are described.

1952. MODERN METHODS . . . KEY TO AGRICULTURE IN TROPICAL REGIONS. Crops & Soils 5 (1): 16-19, illus. (Amer. Soc. Agron.)

The author refutes pessimistic outlooks on agricultural possibilities in the world's great rain-forest areas, particularly the Amazon and Congo basins. Potentially these areas could produce many valuable tree crops; and with

modern methods alluvial lands could support an extensive agriculture--despite periodic flooding.

*Wangaard, F. F.
1952. THE STEAM-BENDING OF BEECH.
Northeast. Forest Expt. Sta., Beech Util. Series No. 3. 26 pp., illus. Upper Darby, Pa.

Beech is one of the relatively few woods that are particularly well adapted to bending. Preparation of the wood, bending methods, setting of the bend, and bending characteristics of beech are described. Because of the tendency of beech to check on drying, special measures are recommended to control this. Properties of the bent wood and uses and products are also discussed.

1952. THE STEAM BENDING OF BEECH.
Jour. Forest Prod. Res. Soc. 2 (4): 35-41, illus.

(See above.)

*Weitzman, Sidney.
1952. MOUNTAIN LOG ROADS--DESIGN AND CONSTRUCTION.
W. Va. Conservation 16 (3): 16-21, illus.

Suggests methods of constructing logging roads in mountainous West Virginia, where the customary practice is to run roads straight up and down hill, which results in erosion and damage to watershed values. In laying out the road, grades should be kept low by running the road slantwise up the mountain side and by using switchbacks. Use of maps, aerial photos, and ground reconnaissance in laying out the road are described. In constructing, the author advocates building the road from the top down. Maintenance measures such as water bars are important in preventing erosion.

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1952. MOUNTAIN LOGGING--EQUIPMENT AND METHODS.
W. Va. Conservation 16 (5): 10-15, illus.

In the mountainous forest country of West Virginia, the old-fashioned ax and crosscut saw are used in logging, along with horses for skidding. Experimental logging on the Fernow Experimental Forest shows that modern methods and equipment help to reduce costs. The author discusses the advantages of the 1-man power saw and the tractor-winch-arch combination used for skidding tree lengths. Crew organization and logging methods are described.

*
Weitzman, Sidney.
1952. MINE TIMBERS--GROWTH AND HARVEST.
W. Va. Conservation 16 (10): 4-5, 22-24, illus.

About a fourth of the timber cut in West Virginia goes into the coal mines. To determine what method of cutting will insure a supply of mine timbers, three intensities of forest management ("fair," "good," and "high-order") were tried on the Fernow Experimental Forest. Results indicate that producing 1,000 board feet of mine timbers was least expensive under the "high-order" cutting.

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1952. MOUNTAIN LOGGING.
South. Lumberman 185 (2321): 199-202, illus.

Recommends (1) planning and constructing an efficient skid-road system in advance of logging, and (2) using modern methods and equipment that can be adapted to mountainous terrain. Methods of laying out and maintaining good skid roads are outlined, and modern logging methods and equipment suitable for this country are discussed.

1952. FORESTRY (in West Virginia).
W. Va. Watershed Devlpmt. Conf. Proc. 1950: 31-37. (Charleston.)

A general discussion of the importance of forestry in watershed development. Forestry should be aimed to provide protective cover on watersheds as well as to produce a continuous supply of timber products.

*
--- and Holcomb, Carl J.
1952. HOW MANY TREES ARE DESTROYED IN LOGGING?
Northeast. Forest Expt. Sta., Northeast. Res. Note 17. 4 pp. Upper Darby, Pa.

Studies of three experimental logging jobs in West Virginia indicate that damage to the residual stand need not be a deterrent to partial cutting. Damage to partially cut stands (cut to 16-inch and 14-inch diameter limits) was light--both in number of trees and volume. Once big hold-overs are removed, damage in future partial cuttings should be even lighter.

*
--- and Trimble, G. R., Jr.
1952. SKID-ROAD EROSION CAN BE REDUCED.
Jour. Soil and Water Conserv. 7: 122-124, illus.

On an experimental logging job in West Virginia, four different kinds of skid road were tested in conjunction with four levels of cutting intensity. Amount of erosion was studied at cross sections of the skid roads. Great differences in erosion were found. The authors recommend plan-

ning an efficient skid-road system that avoids steep gradients, and installing simple water bars to keep the road drained.

Westveld, Marinus.
1952. A METHOD OF EVALUATING FOREST SITE QUALITY FROM SOIL, FOREST COVER, AND INDICATOR PLANTS. Northeast. Forest Expt. Sta., Sta. Paper 48. 12 pp., illus. Upper Darby, Pa.

Growing forest species on sites to which they are not naturally well adapted can lead to serious silvicultural and pest-control problems. The climax type is offered as a guide to growing the right tree on the right site. The author shows how climax type for an area can be interpreted from study of the present forest cover, the soil type, and the ground vegetation. From these three interpretations a basic management map of an area can be prepared, showing climax type and site quality.

*Whelan, Donald E., Miller, Lemuel E., and Cavallero, John B.
1952. A METHOD OF DETERMINING SURFACE RUNOFF BY "ROUTING" INFILTRATED WATER THROUGH THE SOIL PROFILES. Northeast. Forest Expt. Sta., Sta. Paper 54. 15 pp., illus. Upper Darby, Pa.

To determine the capacity of a soil to absorb and store water, a new method of calculating infiltration was developed, by "routing" infiltrated water through the soil profile. This is done by carefully accounting for the time stages in the movement of the wet front and the changes in water storage in each soil horizon. A sample "routing" is presented as an illustration.

*Williamson, M. J.
1952. RABBITS DAMAGE METASEQUOIA PLANTINGS AT BELTSVILLE, MD. Northeast. Forest Expt. Sta., Northeast. Res. Note 12: 3-4. Upper Darby, Pa.

Several small plantings of Metasequoia glyptostroboides at the Beltsville Experimental Forest were damaged by rabbit browsing. The species seems able to recover after serious injury; in one case a tree nipped off to a 3-inch stub developed a new shoot that grew 14 inches in one season. Growth records indicate Metasequoia does best on fairly moist sites relatively free of competing vegetation.

*Wray, Robert D.
1952. ANY FORESTER CAN USE AERIAL PHOTOGRAPHS. Jour. Forestry 50: 26-30, illus.

The author takes the reader on an imaginary field trip and shows him how easy it is to use aerial photographs

for finding his way around in the woods and for locating randomly selected sample plots in unfamiliar territory.

*Wray, Robert D.
1952. FOREST STATISTICS FOR WEST VIRGINIA. Northeast. Forest Expt. Sta. Forest Statis. Ser.: W. Va. 1. 48 pp. Upper Darby, Pa.

A statistical report on results of the forest survey, presenting tabular data and a brief outline of the present forest situation. Of the total land area of 15½ million acres, 64 percent is forested. This is hardwood country. The commercial forests contain 17½ billion board feet of saw timber, more than one-fourth of it red oak.

*---------- and Banks, Wayne G.
1952. FOREST STATISTICS FOR NEW YORK FOREST DISTRICT NO. 7. Northeast. Forest Expt. Sta., Forest Statis. Ser.: N.Y. 2. 17 pp. Upper Darby, Pa.

Forest survey statistical data on forest area, ownership, forest types, condition of the forests, and timber volumes for New York Forest District No. 7 (St. Lawrence County). Tabular data and brief textual description.

*---------- and Banks, Wayne G.
1952. FOREST STATISTICS FOR WESTERN MARYLAND. Northeast. Forest Expt. Sta. Forest Statis. Ser.: Md. 1. 20 pp., illus. Upper Darby, Pa.

The first of a series of preliminary reports on the forest areas and timber volumes in the State of Maryland. The Western Maryland area (Garrett, Allegany, Washington, Frederick, Carroll, Montgomery, and Howard Counties) covers 2 million acres, of which nearly 1 million are forested. The area has 1½ billion board feet of live saw timber, 30 percent in red oak, another 25 percent in white oak and chestnut oak.

*Wright, Jonathan W.
1952. POLLEN DISPERSION OF SOME FOREST TREES. Northeast. Forest Expt. Sta., Sta. Paper 46. 42 pp., illus. Upper Darby, Pa.

Pollen-dispersion distances of several forest species were computed from pollen counts on microscope slides exposed at different distances from source trees. Effects of wind velocity and direction, topography, diameter and rate of fall of the pollen grain, turbulence of the atmosphere, and height of pollen source are discussed. The pollen dispersion data are applied in predicting genetic differentiation and race formation of the species.

Wright, Jonathan W.

1952. BREEDING BETTER TREES TO PLANT PENNSYLVANIA. Pa. Forests 37: 46-47, illus.

Description of tree-breeding work of the Northeastern Forest Experiment Station. The different kinds of crosses being tried are outlined briefly, and some of the most promising crosses are listed. Techniques are also described.

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1952. A DIRECTORY OF FOREST GENETICS RESEARCH IN THE UNITED STATES AND CANADA. Northeast. Forest Expt. Sta., Sta. Paper 53. 10 pp. Upper Darby, Pa.

In recent years the number of persons engaged in forest-genetics research has increased rapidly. The author lists agencies and individuals engaged in this research, species studied, and kind of work being done.

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Gilbert L. Varney	Forester (For. Influences)
William D. Huttinger	Forester (For. Influences)
Donald E. Whelan	Hydrologist
Margaret H. Russell	Secretary (Typist)

FOREST UTILIZATION SERVICE

Charles R. Lockard	Technologist
Frederick C. Simmons	Forester
Clotilda F. Stenta	Clerk-stenographer

DIVISION OF FOREST INFLUENCES

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Howard S. Potter (on educational leave)	Forester (Ecology)

ADIRONDACK RESEARCH CENTER

John R. Curry	Forester (Res. Administration)
Francis M. Rushmore	Research Forester (General)
Gerald C. LaVoy	Clerk-typist
Harold E. Martin	Strawboss

ALLEGHENY PLATEAU RESEARCH CENTER

Ashbel F. Hough	Forester (Silviculture)

ANTHRACITE RESEARCH CENTER

Milford C. Howard	Forester (Res. Administration)
William E. McQuilkin	Forester (Silviculture)
Rosamond M. McElwee	Clerk-stenographer

Pocono Experimental Forest

Stanley M. Filip	Research Forester (General)
Willis T. Borneman	Forestry Aid (Research)

COASTAL OAK PINE RESEARCH CENTER

Lebanon Experimental Forest

Silas Little, Jr.	Forester (Silviculture)
Horace A. Somes	Forestry Aid (Research)

DELAWARE BASIN RESEARCH CENTER

Nedavia Bethlahmy	Soil Scientist
Irvin C. Reigner	Forester (For. Influences)
Perma A. Zerfass	Clerk-typist

MOUNTAIN STATE RESEARCH CENTER

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Carl J. Holcomb	Research Forester (General)
George R. Trimble, Jr.	Forester (For. Influences)
Eli J. Fenchak	Forestry Aid
Carl R. Barr	Forestry Aid (Research)
Burley D. Fridley	Forestry Aid (General)
Kathleen P. Hammack	Clerk-stenographer
Daniel W. Hardy	Strawboss
Roy A. Hardy	Woods Laborer II
John H. Long	Forest Worker II
Ronald C. Miller	Forest Worker II
Letus C. Sherman	Forest Worker II

PENOBSCOT RESEARCH CENTER

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Arthur C. Hart	Forester (For. Mgt. Res.)
Ted J. Grisez	Research Forester (General)
Eugenia C. Goodine	Clerk-stenographer
Preston A. Morse	Strawboss
Bernard L. Baker	Woods Laborer I

VIRGINIA PINE HARDWOOD RESEARCH CENTER

Beltsville Experimental Forest

Albert G. Snow, Jr.	Forester (Res. Administration)
Richard H. Fenton	Research Forester (General)
Thomas W. Church, Jr.	Research Forester (General)
Ralph P. Broomall	Forestry Aid (Research)
Harold F. Ford	Forestry Aid (Research)
Sumner F. Ricker	Forestry Aid (Research)

WHITE PINE HARDWOODS RESEARCH CENTER

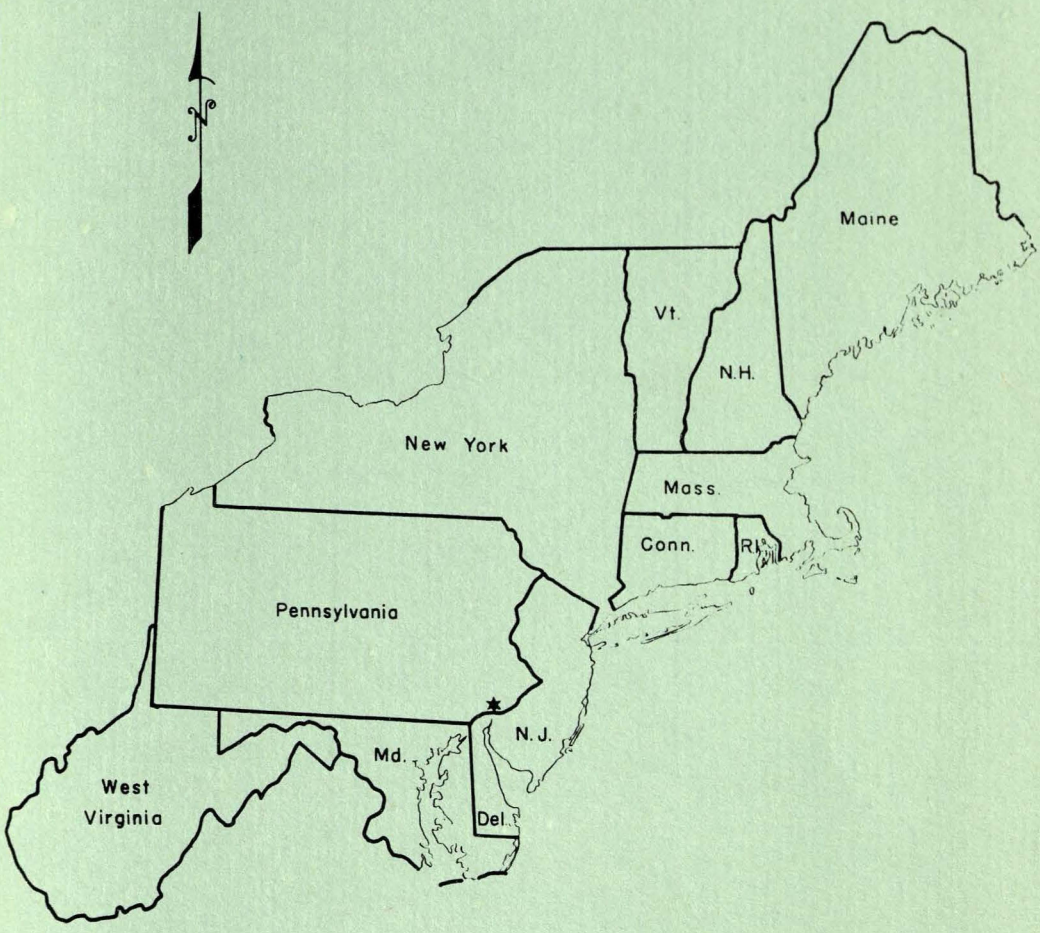
Victor S. Jensen	Forester (Res. Administration)
Adrian M. Gilbert	Research Forester (General)
Russell J. Hutnik	Research Forester (General)
Robert W. Wilson, Jr.	Research Forester (General)
Marguerite M. Stothart	Clerk-stenographer

Hopkins Experimental Forest

Frank E. Cunningham	Forester (For. Mgt. Res.)
Raymond W. Lavigne	Forest Worker II

Massabesic Experimental Forest

Thomas W. McConkey	Forester (For. Mgt. Res.)
Charles E. Swett	Forestry Aid (Research)
Richard E. Burbank	Forest Worker II
Robert E. Burns	Forest Worker II



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